Tomahawk Short Wheel Base Recumbent Lowracer

ANOTHER ATOMIC ZOMBIE™ EXTREME MACHINES ADVENTURE

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INTRODUCTION

The Tomahawk Lowracer is all about the speed! The extremely laid back seating position means that you will always be able to deliver your full energy to the cranks, as well as cheat the wind in ways that are impossible on a standard upright bike.

The short wheelbase configuration offers agile and responsive handling characteristics that make it feel as though you are piloting a jet fighter. With the adjustable bottom bracket and unique frame design, riders with shorter legs will be able to pilot the Tomahawk without dealing with crank interference with the front wheel. Before you start cutting your frame tubing, it is a good idea to read the entire plan so that you understand how modifications may affect the rest of the build. There is plenty of room for your own design changes, and the Tomahawk can be built using the parts you have available to you.

WELDING HEALTH HAZARDS

All welding processes produce fumes and gases to a greater or lesser extent. Galvanized steels produce added fumes from the vaporized zinc coating. Fumes from welding galvanized steel can contain zinc, iron and lead. Use precautions, including high-velocity circulating fans with filters, good ventilation, air respirators and fume-extraction systems.

MAKING THE REAR FORKS

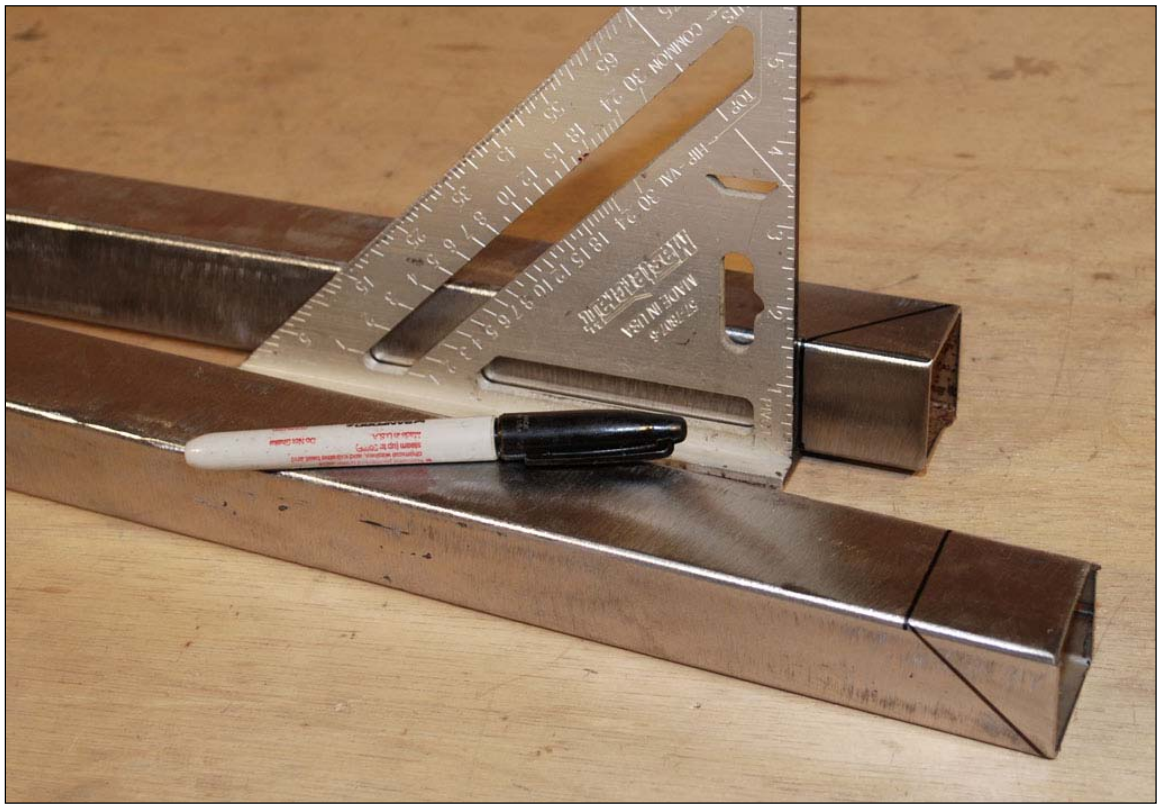

Figure 1 – Cutting the two rear fork leg tubes

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The entire Tomahawk Lowracer frame is made from 1.5 inch mild steel square tubing with a 1/16 inch wall thickness. This tubing can be ordered from any steel supplier and is very easy to cut and weld. Steel suppliers like to rate tubing wall thickness using a gauge number, so 1/16 wall tubing will be called 16 gage tubing. Although there is a slight difference between the two, your best bet is to tell them that you want a length of 1.5 inch square tubing with a wall thickness as close to .0625 inch (1/16) as you can get. If you are a heavy rider (over 250 pounds), then you should ask for the next size after that, which will likely be 14 gage tubing, or .078 inch wall tubing. Round tubing should be avoided for this project, as it will make angle cuts much more difficult to get correct.

To make building this bike easier and to help eliminate errors that might occur from making angled cuts that are slightly off, the build will progress from one step to the next, often using the last step as a guide for the next. For instance, we will begin by creating the rear forks that will then be used to hold up the rear seat tube at the correct angle for welding. By working on one part at a time, you can easily make alterations to the plan or not worry so much of your bicycle components are not exactly the same as mine. You could even make radical design changes, such as using a 20 inch rear wheel instead of a 26 inch wheel, and still end up with a perfectly functional bike. I also recommend that you read over the entire plan before starting, and try to look ahead a few steps to see why cuts or welds are done in certain orders.

The first two tubes you will need to cut will form the legs of the rear forks, which hold the rear wheel to the top of the rear seat tube. Start by cutting two 17 inch piece of the 1.5 inch square tubing. This length (17”) is a bit longer than necessary so that the angles can be derived as the part is being made. The two rear fork leg tubes shown in Figure 1 will also have 45 degree slices cut at one end of the tube. This 45 degree cut gives the completed rear forks a more streamlined look.

Figure 2 – Cutting the 45 degree slices form the fork legs

After marking one end of each of the fork legs using a 45 degree square (shown in Figure 1), cut away the slices using whatever method you normally use to cut metal. I use a 3/32 cut-off wheel (zip

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disc) in my angle grinder for all cutting, but a hacksaw will also work if you are not yet comfortable or highly accurate with your angle grinder. The two 45 degree slices are shown cut away from the fork legs in Figure 2. These scraps can later serve as material for tubing end caps, so don't toss them away.

Figure 3 – Cutting metal to make the end caps

The open ends of the fork legs need to be capped off to make the tubing rigid and to seal the inside from the elements. Without the end caps, the tubing would not be rigid enough for your frame, and it would certainly not look very professional. End caps can be made by cutting some 1/16 wall sheet metal or even by cutting a section of the 1.5 inch tubing you are using to make the Tomahawk frame. The two scraps removed from the ends of the tubing earlier are not long enough to make these caps due to the extra length needed to cover the 45 degree cut. The caps will need to be 1.5 inches by 2.25 inches to cover the holes. Figure 3 shows one of the end caps tack welded to the fork leg, ready to be welded all the way around.

Figure 4 – Cleaning the tubing end caps

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The end caps are first welded all the way around as shown in Figure 4, and then ground clean using a sanding disc (flap disc). A flap disc is a grinder wheel that has multiple sandpaper strips attached to it, and it does great work when cleaning up a welded area. Non-critical welds that do not see much stress can be safely ground flush, but those under high stress should not be ground unless you are confident with your welding abilities. I will only show non-critical welds ground smooth throughout this entire plan.

Figure 5 – The capped read fork leg tubes

Weld and clean both end caps on both fork leg tubes as shown in Figure 5. Chances are that you will find small pits and gaps after using the flap disc to grind down the area. A few spot fills with the welder will be needed to make a perfect seam. Body filler can also be used, but that is cheating!

Figure 6 – Mark the fork legs to a length of 14.5 inches

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The rear forks must spread outwards equally on each side from the frame towards the rear axle as can be seen later in Figure 26. Rather than try to make these subtle angles from a drawing and hope they are accurate, we will use a system that ensures the angles are correct without even knowing what they are. I use this method as much as possible, as it eliminates mistakes and complex cutting.

Start by marking a line 14.5 inches from the longest end of each fork leg as shown in Figure 6. Using a square, trace this line around the tubing, and check to ensure that both fork legs have the line in the exact same place as they are held together.

Figure 7 – Tack weld the fork legs 5.25 inches apart

To properly position the axle between the fork legs, a distance of 5.25 inches needs to be between the dropouts. As shown in Figure 7, tack weld the tips of the fork legs (on both sides) to some straight metal edge so that they are exactly 5.24 inches apart. A piece of 1.5 inch tubing is perfect for this job, and can simply be cleaned up later after breaking off the tack welds. If your rear hub is non-standard, then adjust to compensate.

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Figure 8 – The tops of the fork legs must form a triangle

To ensure that both fork legs have been tack welded in place at the same angle, press the legs together until the tops meet each other perfectly as shown in Figure 8. This forms a perfect triangle, and places both fork legs at the same angle on both sides. An adjustable square can be used to compare each side, or you can trace a line on paper, and then flip the assembly for comparison.

Figure 9 – Spread the fork legs to 2 inches at the line

Place a tape measure at the inside line on each fork leg as shown in Figure 9 and then carefully spread them apart until they stay at the 2 inch mark. With the tack welds working as a hinge, it should be easy to pry the legs apart by placing your fingers into the tube to force them into position.

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Figure 10 – Comparing the two leg angles

The two legs will likely pry apart at the same exact angle, but a quick check using an adjustable square or even a bit of paper to trace on would be a good idea. To check with an adjustable square, set it on one side and then compare the other as shown in Figure 10. If you can't see any error by eye, then it is close enough.

Figure 11 – Setting up a guide to mark a line

The fork legs will be trimmed across the top of the line so that they form a parallel line to the piece of metal that the legs are tack welded to. Figure 11 shows a guide tube being used as a straight edge to mark the line. Another way to check the fork leg angles is to measure the distance from the straight edge

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to the bottom tube; it should be the same on both sides as the straight edge sits across the outer points of the two lines.

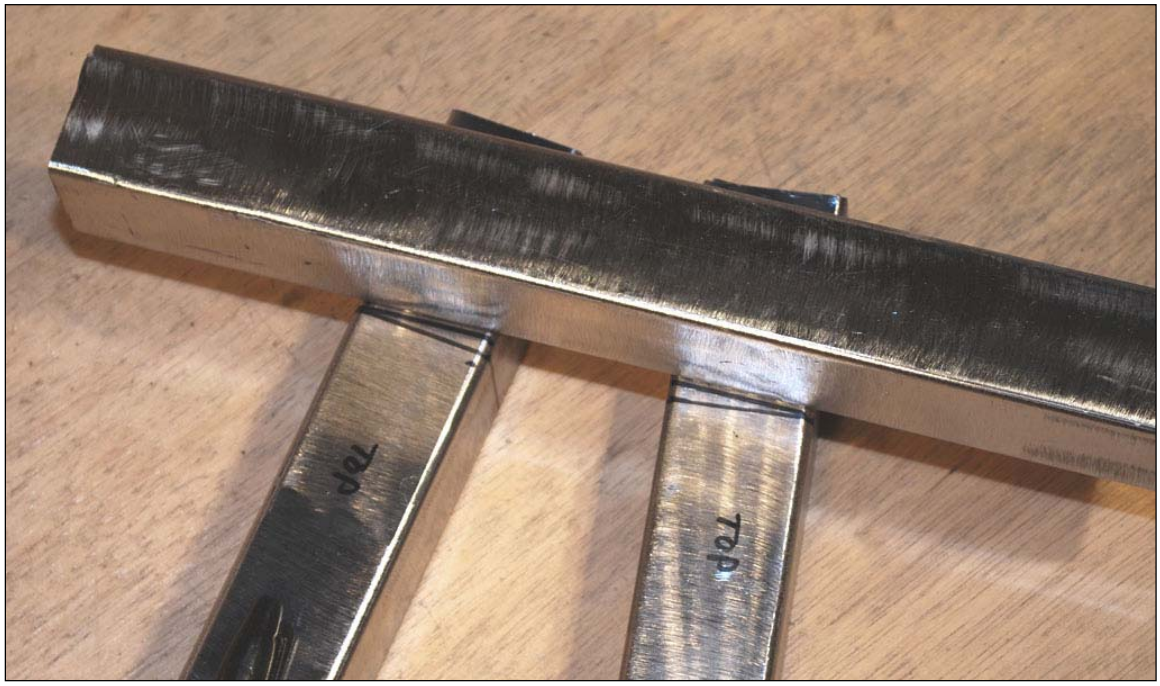

Figure 12 – Positioning the straight edge to draw the cut line

Figure 12 shows the proper position for the straight edge, as well as the new cut line draw parallel across both fork legs. Remember that the distance between the fork legs at the line should be 2 inches (shown back in Figure 9). Flip the fork legs over and draw the same cut line on the other side as well.

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Figure 13 – Making both legs equal after cutting

To cut the fork legs, bend them back and forth to break them free of the tack welds, and then finish the inside lines by joining the points with your square. After cutting both legs, place them both together so the tips line up and then grind any differences where you just cut. Placing the parts together in a vice as shown in Figure 13 makes it easy to fix any small errors in size. I use a flap disc for this work, as it lessens the chance of taking away too much metal.

Figure 14 – Joining the two fork legs together

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To complete the rear forks, they must be joined together by a small tube so that they are 5.25 inches apart at the open end, and 2 inches apart at the closed end as shown in Figure 14. The small tube that joins the fork legs will need to be 5 inches long in order to reach across the two tubes and the 2 inch distance. Tack weld the top of the new tube and fork legs while the three tubes are placed on a flat surface.

Figure 15 – Checking fork leg alignment

To check the parallel fork leg alignment, hold up the part as shown in Figure 15 to ensure that both legs are as parallel as possible. With only a few tack welds holding the parts together, it will be easy to tap them into alignment with a hammer, if necessary. Once alignment looks visually good, tack weld the bottom of the part to secure the legs to the small joining tube. Also ensure that the 5.25” axle spacing is kept close.

Figure 16 – Welding the sides of the joint first

To minimize the effects of distortion while welding square tubing, the order of welding becomes important. The first weld will be the one to introduce the most distortion as the weld area cools, so

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choose the side that will have the least amount of effect on the part. As shown in Figure 16, the outer edges are welded first, as the distortion will be minimal here, and it will not affect the most important alignment – the parallel alignment of the two fork legs. It's also a good idea to tack weld the straight edge or some bit of tubing between the fork legs while welding to further minimize and distortion.

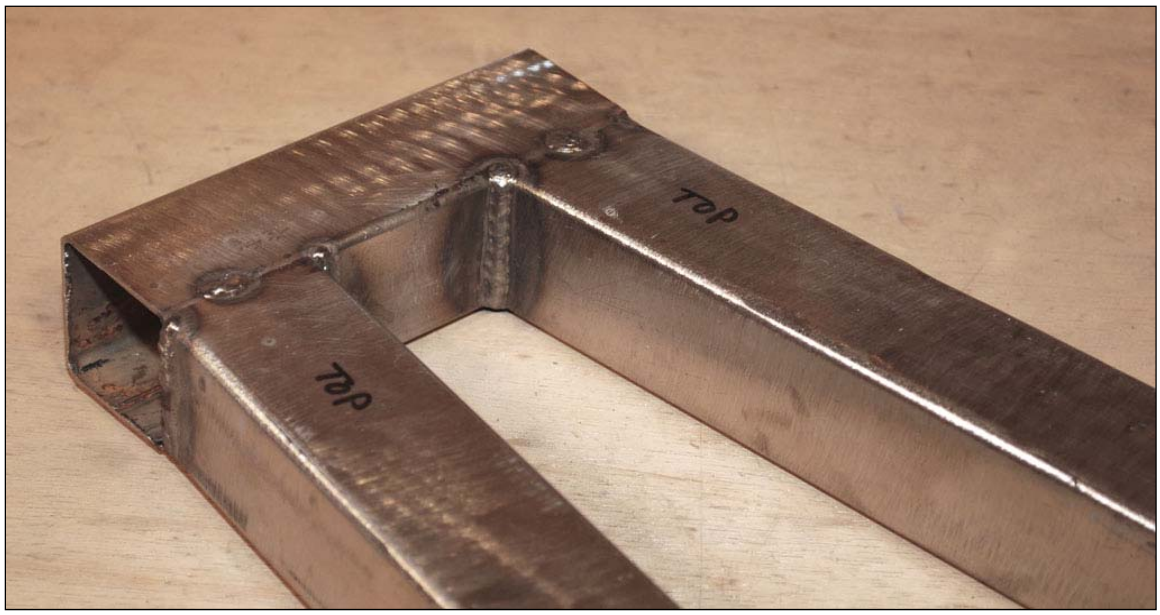

Figure 17 – Weld the inside corners next

The inside corners of the joint as shown in Figure 17 are to be welded next. Distortion will be minimal because the other side of the joint was welded earlier, but it still wouldn't hurt to have that bit of tubing tack welded between the legs to keep the axle spacing perfect. The reason I marked the top of the part is because the tubing seam will end up on the bottom side. Depending on your tubing, the seam may or may not be noticeable after painting.

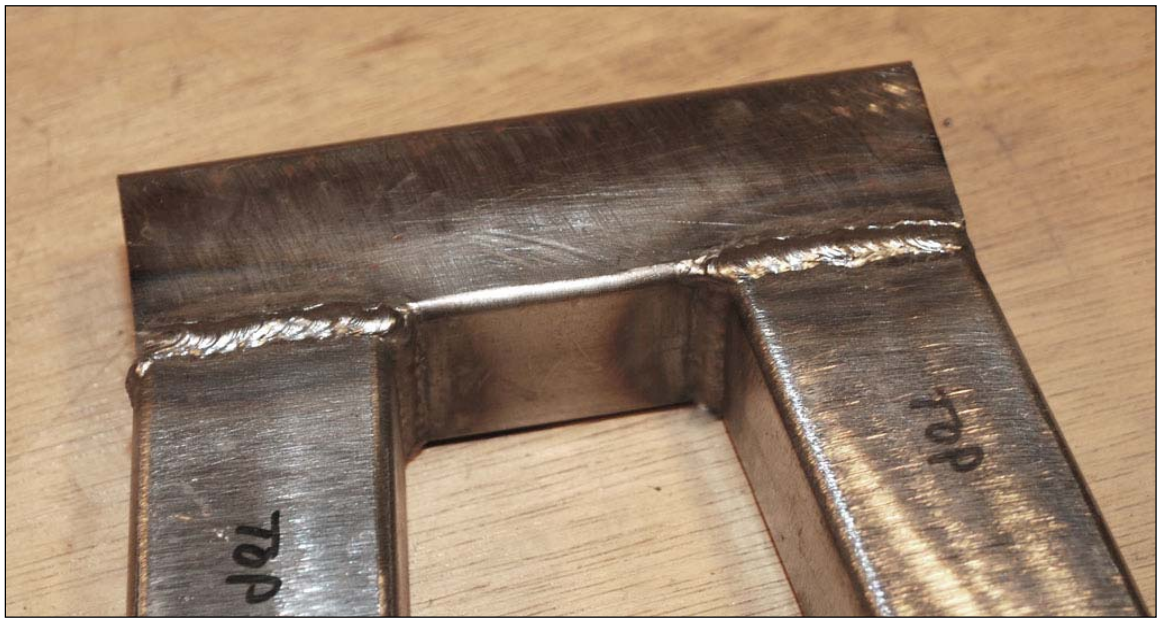

Figure 18 – Completing the top and bottom of the joints

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The top and bottom of the joint can be completed next (Figure 18), but it is a good idea to do both legs in the same order. Each time you weld, check the legs for parallel alignment, and if one leg seems higher than the other, weld the opposite joint, imagining that the weld will "pull" apart somewhat in that direction. Heat distortion becomes very predictable after much practice.

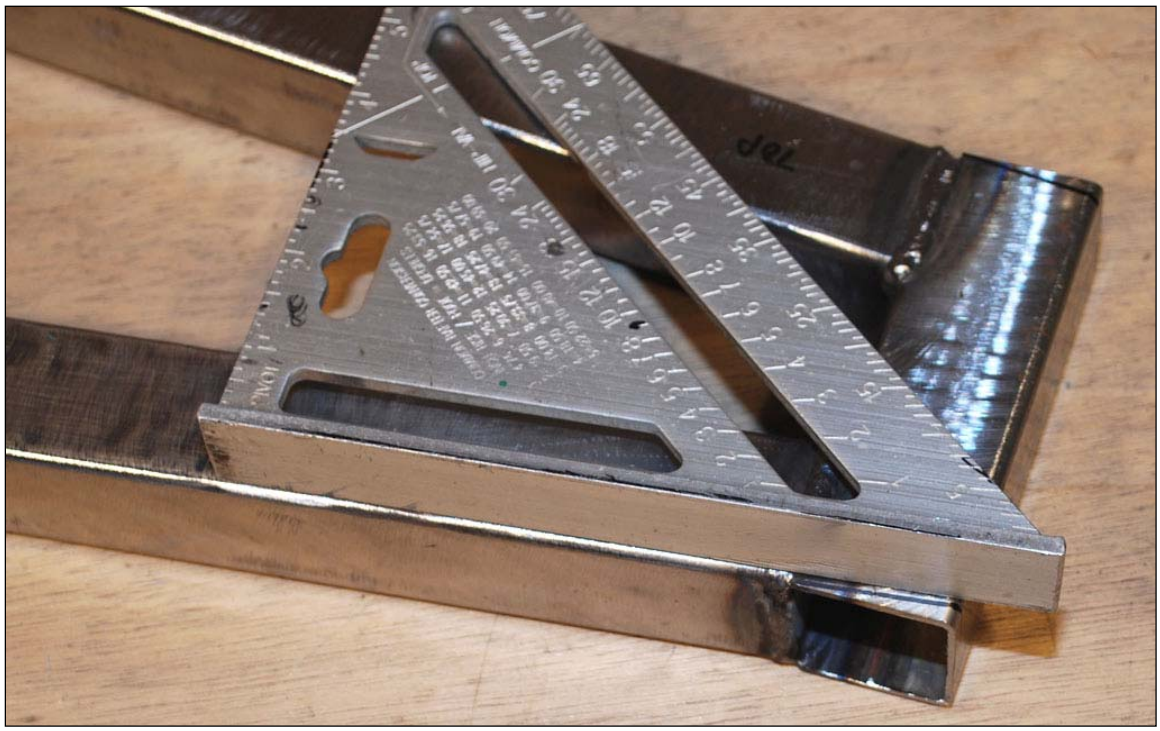

Figure 19 – Trimming the tube to match the angle

The step shown in Figure 19 is actually optional, but it does keep the angle of the fork legs through the entire part. To trim the small tube, place a straight edge along the fork leg, draw a line, then take away the small bit of tubing using a zip disc or hack saw.

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Figure 20 – Capping off the remaining holes

The small joining tube will also need to be capped, and those two bits that were cut from the 45 degree ends of the fork legs should be able to fit the holes once cut into squares. Figure 20 shows the beginning of the capping procedure, using a few corner tack welds to get started.

Figure 21 – Caps welded completely around

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The process of cleaning up a tubing cap does take a bit of work, but when you compare the bulky welded area in Figure 21 to the completed work shown next in Figure 22, the results are certainly worth the effort.

Figure 22 – Rear forks completed

The cleaned up tubing caps are shown in Figure 22 after the pits and holes have been welded and then re-worked with the flap disc. This completes the rear forks. Next will be the rear dropouts that will hold the rear wheel to the fork legs.

REAR DROPOUTS

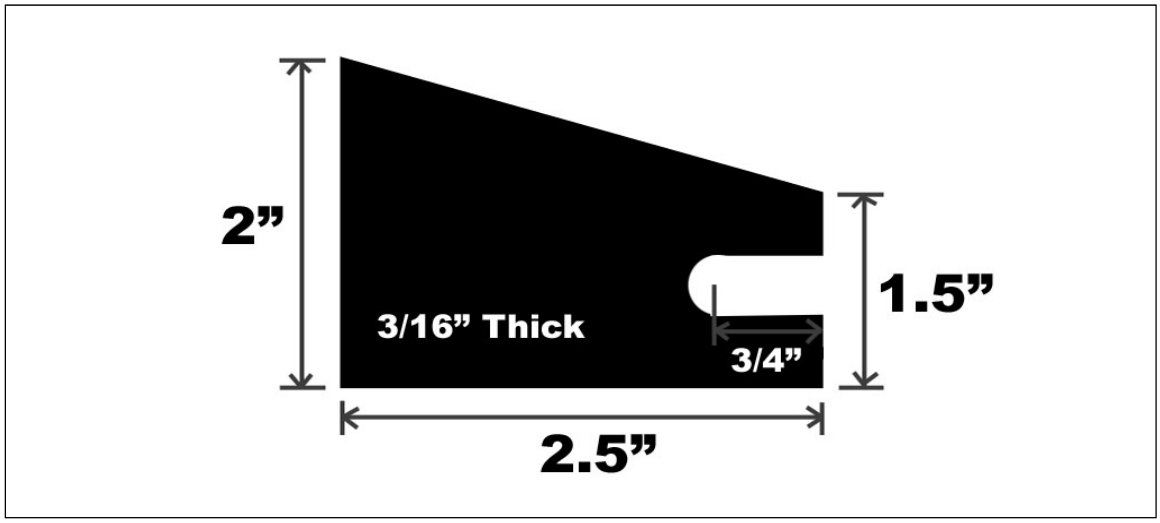

Diagram 1 – Rear dropout dimensions

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The rear dropouts will place the rear axle approximately 2 inches underneath the rear of the fork legs so that there is room for the chain to reach the smallest rear chain ring without rubbing on the fork legs. Unlike a normal bicycle fork, where the axle is placed at the end of the fork legs, this would not work here due to the angle that the chain need to travel from the rear cluster to the idler under the seat. If you look way ahead to some of the completed Tomahawk photos, you can see how the chain leaves the rear freehub cluster. These dropouts are just pieces of 3/16 inch thick flatbar or sheet metal cut to the dimensions shown in Diagram 1.

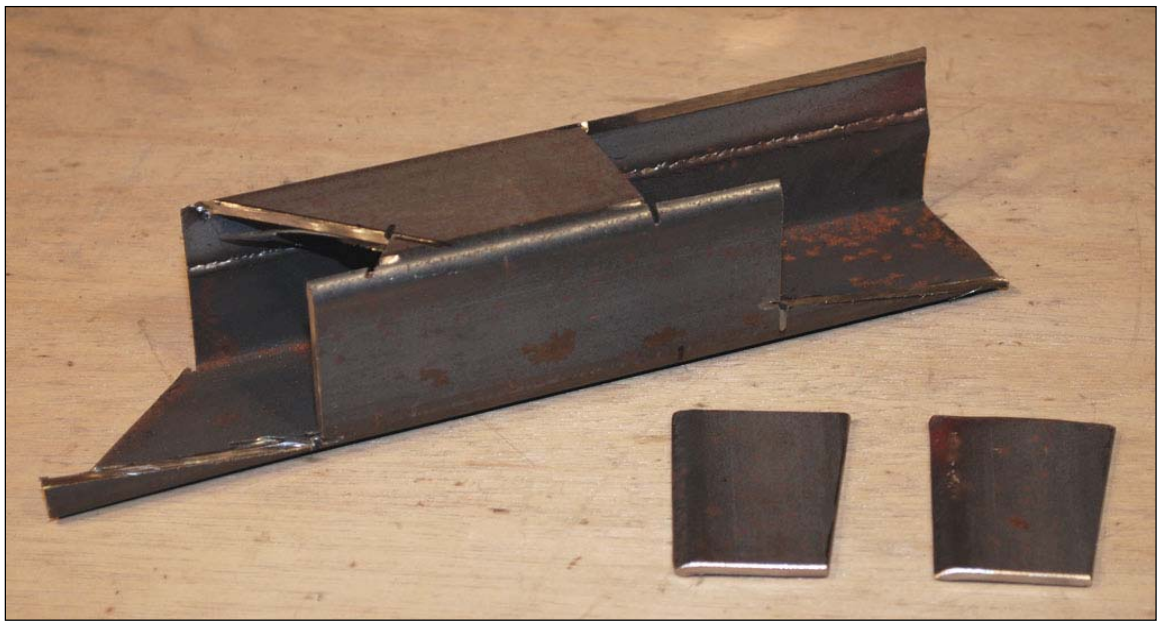

Figure 23 – Cutting out the rear dropouts

Since I have a large collection of scrap tubing bits, I decided to recycle some large 2 inch square tubing (Figure 23) that just happened to have the correct (or close enough) thickness for the rear dropouts. A little less than 3/16 inch thick sheet will be fine, but 1/16 inch thick would be getting a bit on the flimsy side, especially if you like to ride aggressively or have rough terrain to deal with. If you are really concerned about weight, choose the thicker plate, and just drill a few ¾ inch holes in the completed dropouts.

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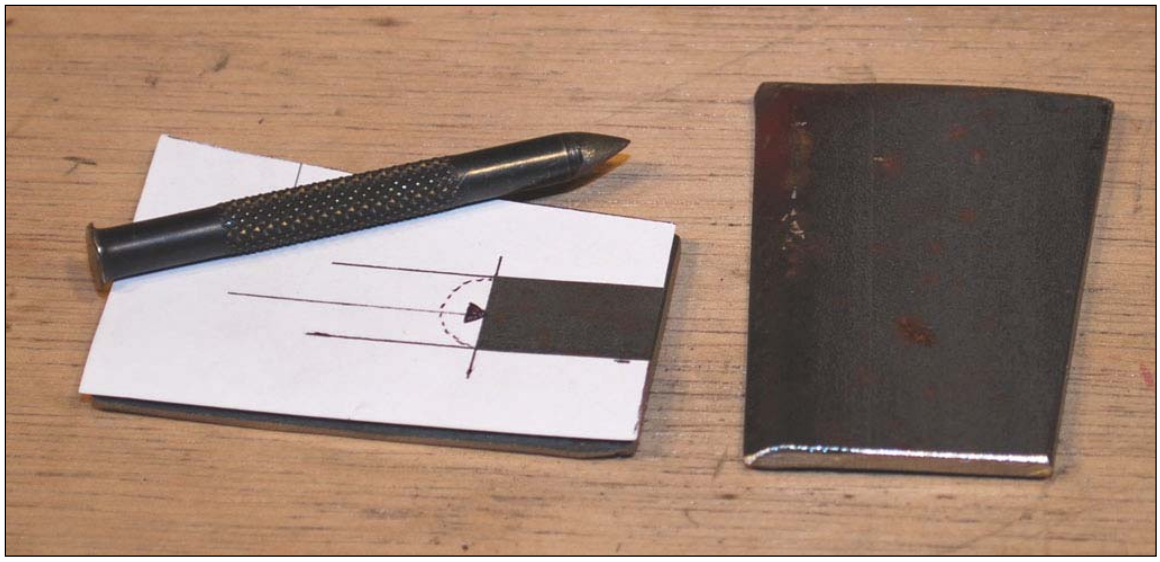

Figure 24 – Using a template to punch the axle holes

As per Diagram 1, there needs to be a slot cut to a depth of ¾ inches to allow your rear axle to bolt onto the dropouts. There are several diameters of rear axles, so you need to choose a final slot diameter that will match your rear wheel. 12mm is a common rear axle size, but there are many variations. To make the slot with a rounded top, carefully measure or use a template as shown in Figure 24 to find the exact point to punch so you can begin drilling. What matters the most is that both dropout slots are in the same place.

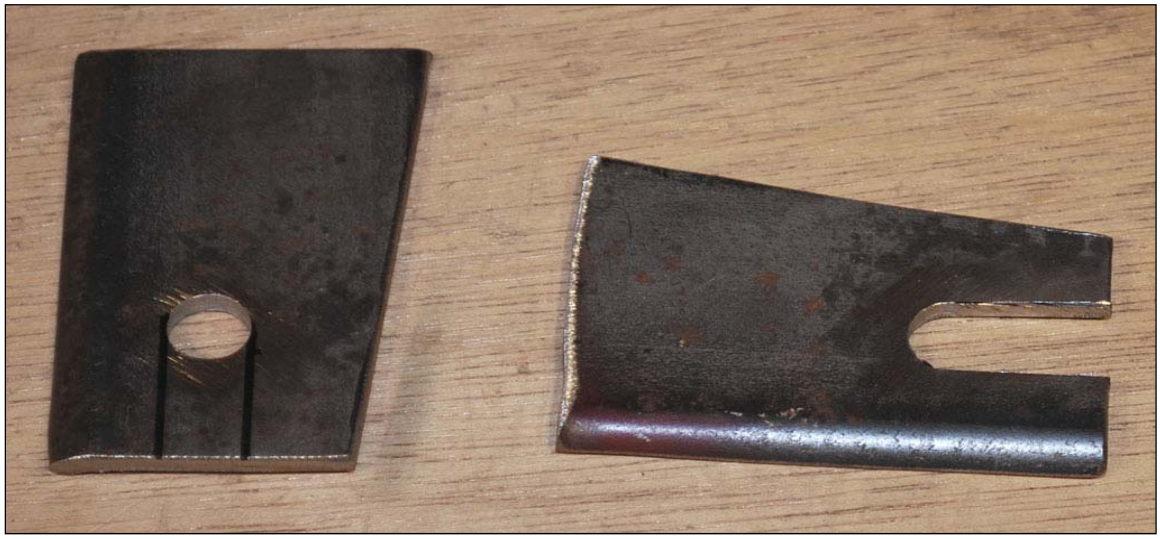

Figure 25 – Making the dropout slots

To drill an accurate hole, I punch the center, then work my way up the drill bit set, starting with the 1/8 inch bit first. A step drill will do the same thing if you have one available. Figure 25 shows the axle holes drilled and the method used to create the rest of the slot. Draw lines from the edge of the holes to the bottom of the dropout and then cut them with a zip disc or hacksaw. After you have the slots cut, place both dropouts together and grind them to be exactly the same if they are not.

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Figure 26 – Using a rear wheel as an alignment guide

The rear dropouts are placed about ½ inch from the end of the fork legs as shown in figures 26 and 27. By using a rear wheel as a guide, you create the perfect spacing for the dropouts, and can check the alignment by looking at the rim between the fork legs. Don't use your best rim when welding the parts to the fork legs, but do use a straight one!

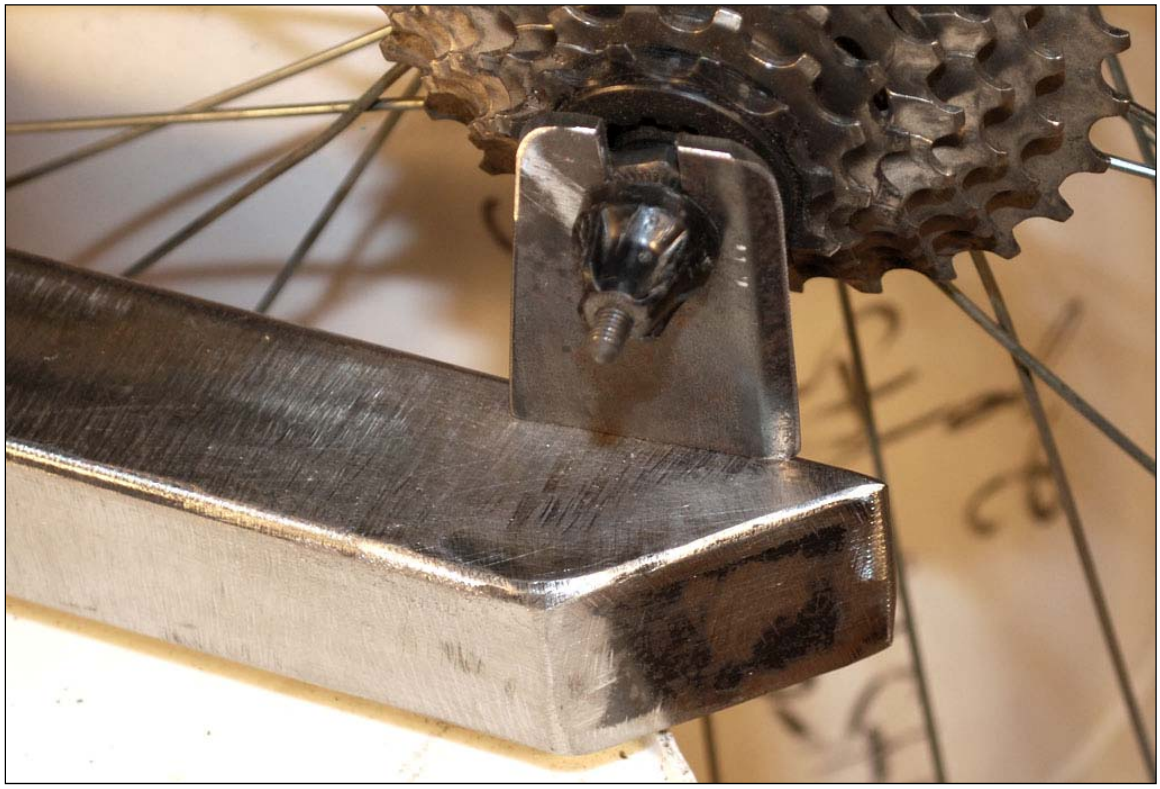

Figure 27 – Positioning the dropouts to be welded

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Because the fork legs are at an angle and the dropouts are parallel with the hub, the rear end of the dropout will be close to the inside edge of the fork leg than the front end as shown in Figure 27. What matters is that the rear wheel is perfectly centered in between the fork legs, which is why it is needed as a guide. Also, make sure that you have enough clearance between the top of the fork and the rear tire, especially if you plan to install one of the new types of ultra fat tires that are now available.

Figure 28 – Checking rear wheel and fork leg alignment

Make one small tack weld on one corner of one of the rear dropouts and then ensure that the rim is perfectly aligned between the two fork legs as shown in Figure 28. Give the wheel a spin to ensure that it does not have a wobble as well. Once the wheel seems to be perfectly aligned, make another small tack weld on the other dropout to secure the axle position.

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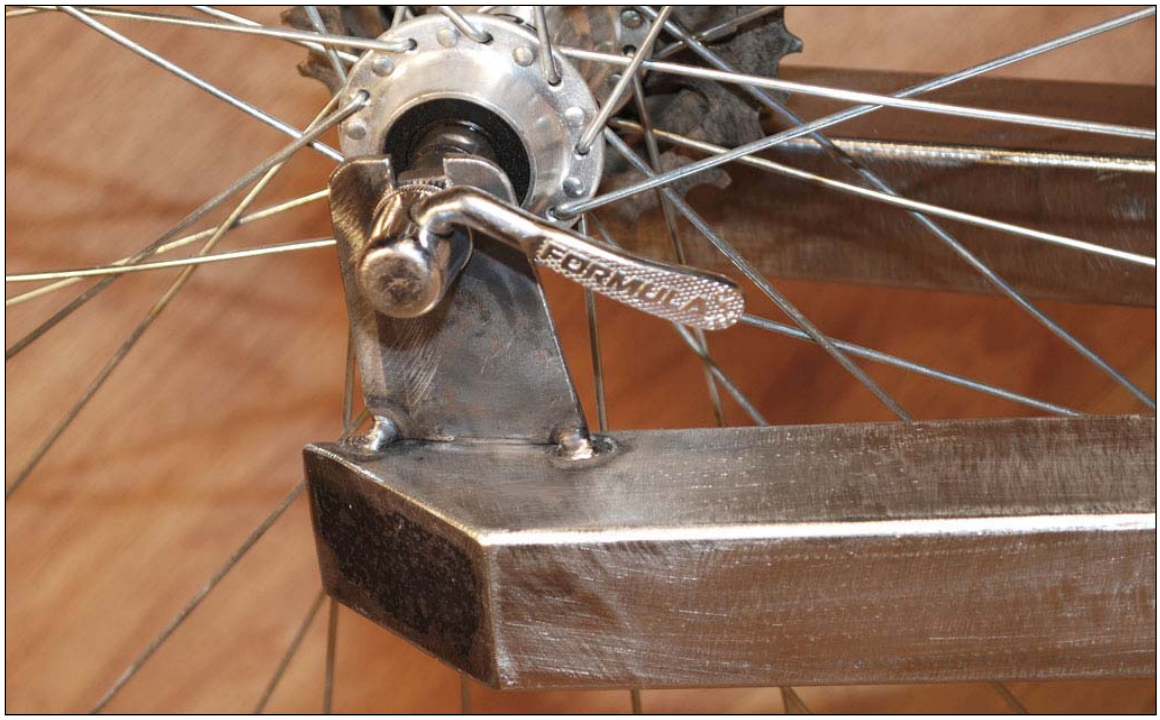

Figure 29 – Securing the dropouts for welding

With a tack weld on each corner of the dropouts as shown in Figure 29, you should be able to pick up the forks and visually inspect the wheel alignment from all angles. The wheel should be perfectly centered and form a 90 degree angle with the small joining tube. This is a good time to try your good rear wheel and tire for one last fitting just to be sure it will have enough room for the tire.

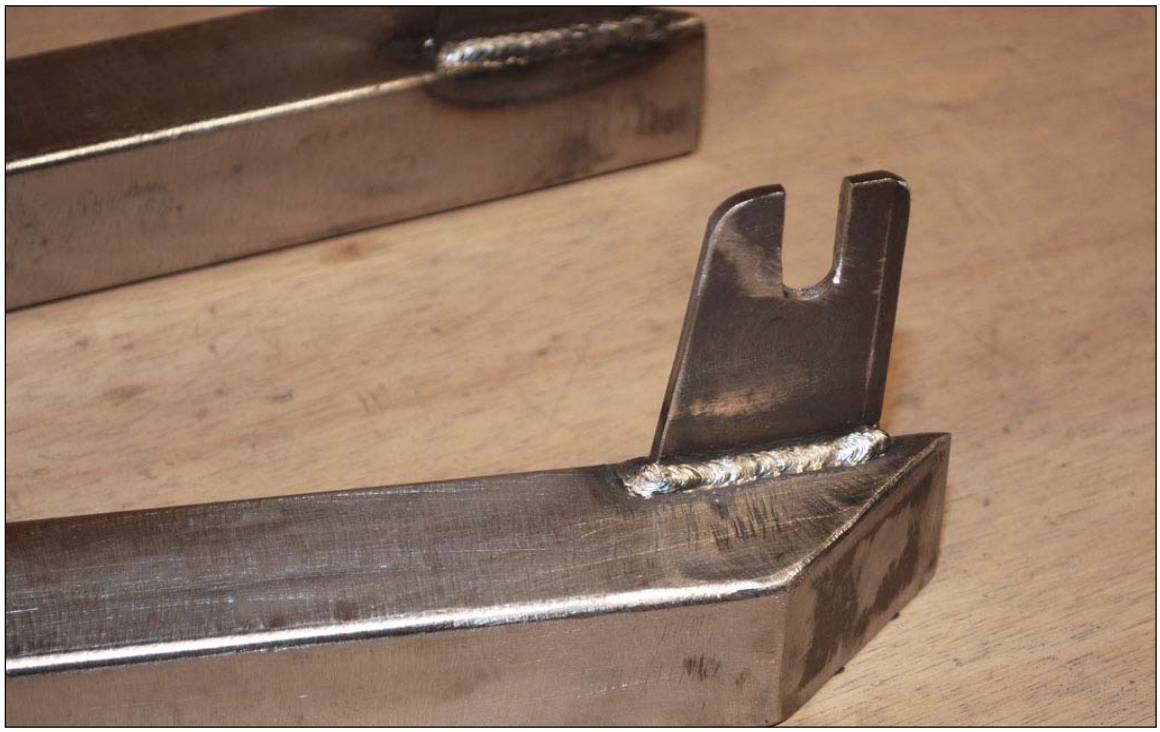

Figure 30 – Welding the dropouts to the fork legs

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It's best to completely weld the dropouts to the fork legs while the rear wheel or at least an axle is still installed as it will keep distortion to a minimum. If you only have a single good wheel, a threaded rod with bolts will also hold the dropouts secure while welding. As shown in Figure 30, start with the outside of the joints.

Figure 31 – Rear fork assembly completed

The inside of the joints can be safely welded as shown in Figure 31 once the outer joints have been completed. You will not need a wheel holding the dropouts in place while completing the inside of the joints, as the outer welds will hold the dropouts secure.

SEAT BACK TUBE

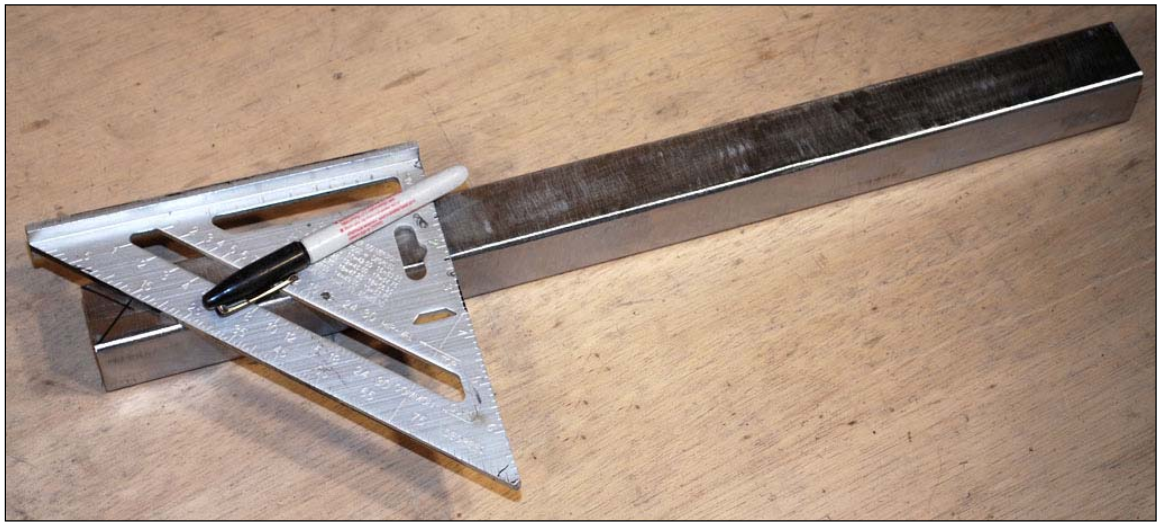

Figure 32 – Cutting the rear seat tube

The rear seat tube (seat back tube) joins the rear forks to the frame and is where your back will be when you are sitting in the seat. This is another length of 1.5 inch square tubing initially cut to a length of

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20 inches. Also shown in Figure 32 is a 45 degree triangular cut that will be made at one end of the tube in order to meet up with the edge of the rear forks, which will be shown later.

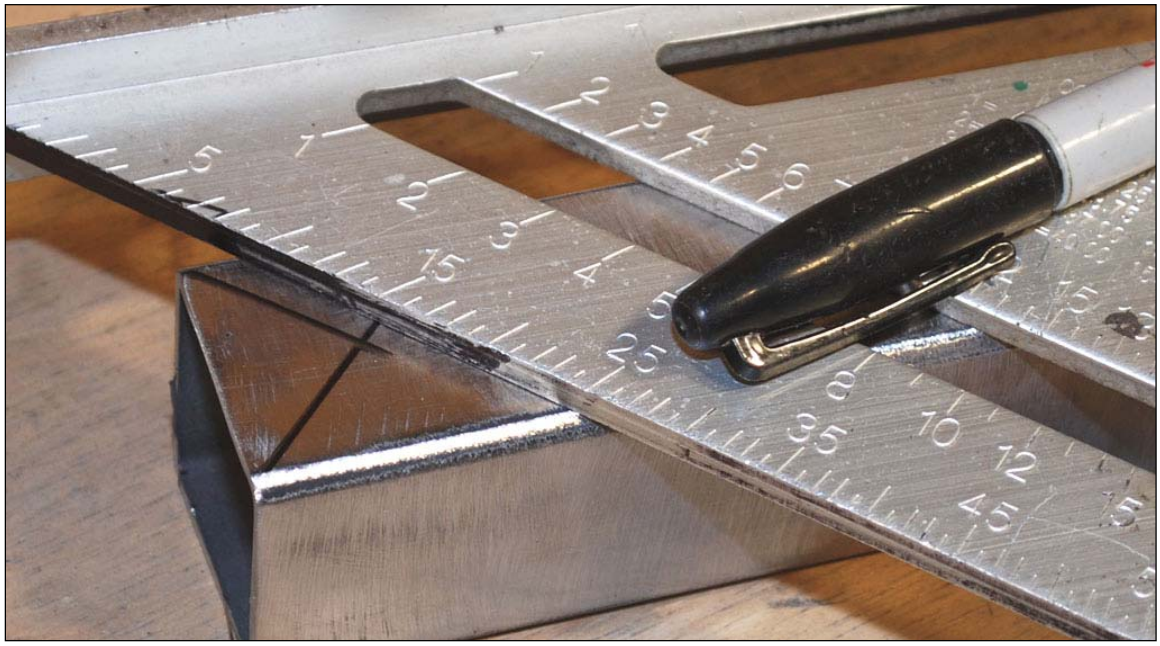

Figure 33 – Marking the triangle to be cut away

The triangle cut is marked by using a 45 degree square to draw lines from each corner until they cross as shown in Figure 33. This is done on both sides of the tube.

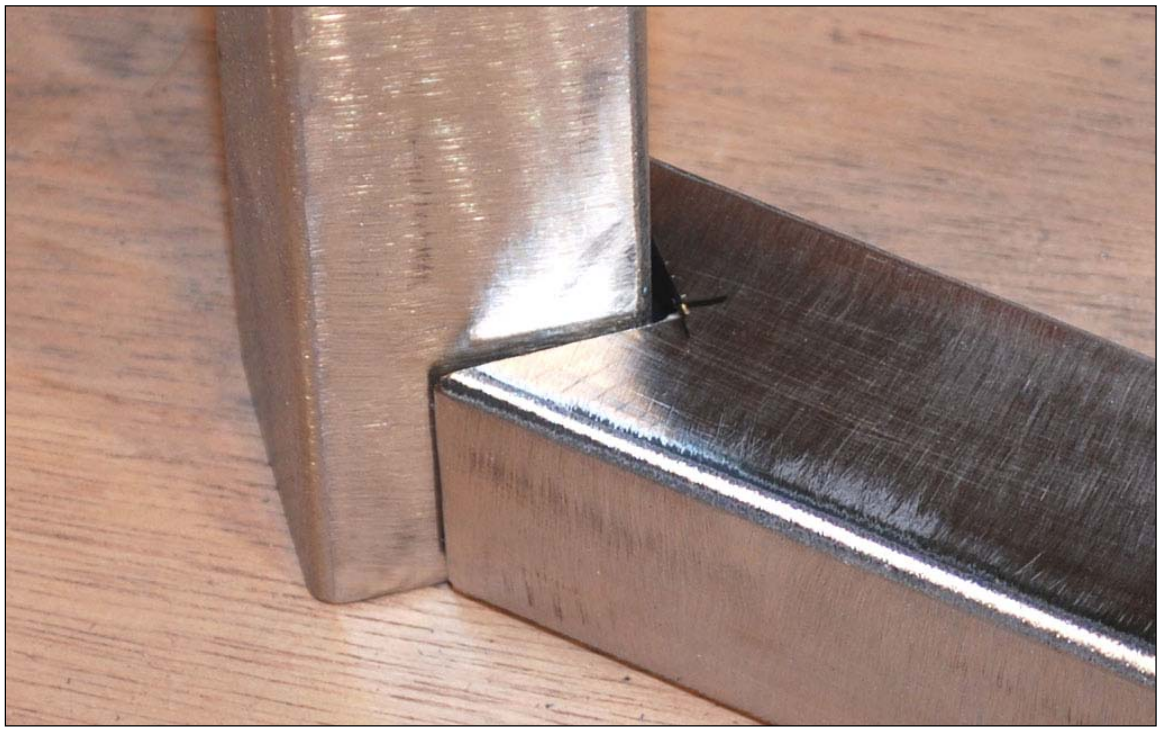

Figure 34 – Test fitting the tubing joint

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Once cut away, the end of the seat tube should fit snugly against any square tube placed into the joint at 45 degrees as shown in Figure 34. If you rest a tube across the joint, holding it up like a “T”, it is easy to check to see of the triangle cutout is the same on both sides.

SEAT BASE TUBE

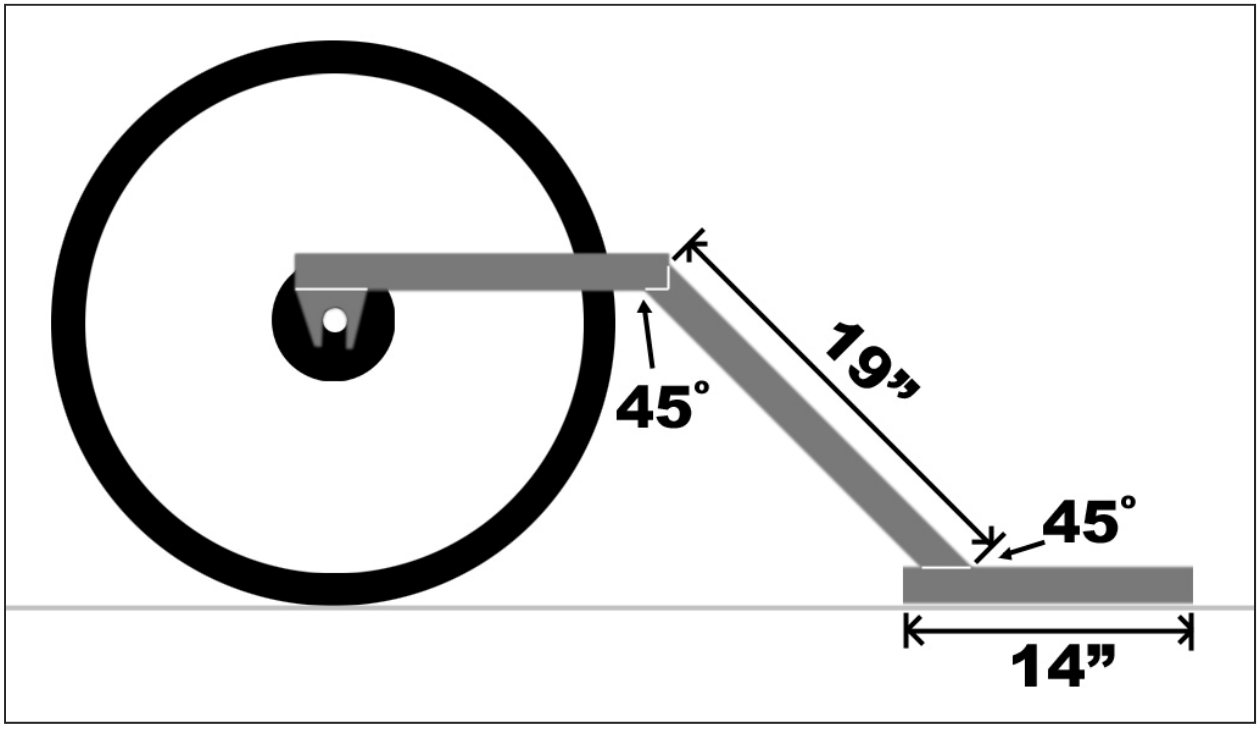

Diagram 2 – Rear frame angles and lengths

The Tomahawk frame will be built from the ground up (literally), so all of the key angles and clearances are easy to get right without any guesswork. If you have plans to make any radical frame changes, then this is the time to work them out. Looking at Diagram 2, you can see that the key angles between the rear fork, seat back, and seat base are all 45 degrees. The seat base tube is shown resting on the ground because with the angles and lengths shown in Figure 2, the frame will sit like this with a rear wheel installed. A few degrees of error will not cause issues with your final design, and you can certainly make changes to the seat angle if you like.

There are two ways to create the seat tube angles. One method is done by cutting 45 degrees on one tube that is welded on top the other, and the other method is done by cutting 22.5 degrees (half of 45) on both tubes so they make a 45 degree angle. The first method (which I will use), allows a bit of the seat base tube to stick out past the seat back tubing, creating a slightly stronger joint that also makes it easy to add a triangular gusset. This method is best for riders weighing more than 250 pounds, as the joint between the seat base and seat back is the most stressed joint on the entire frame. The double angle cut method looks nicer, but requires that your welds are done with good penetration.

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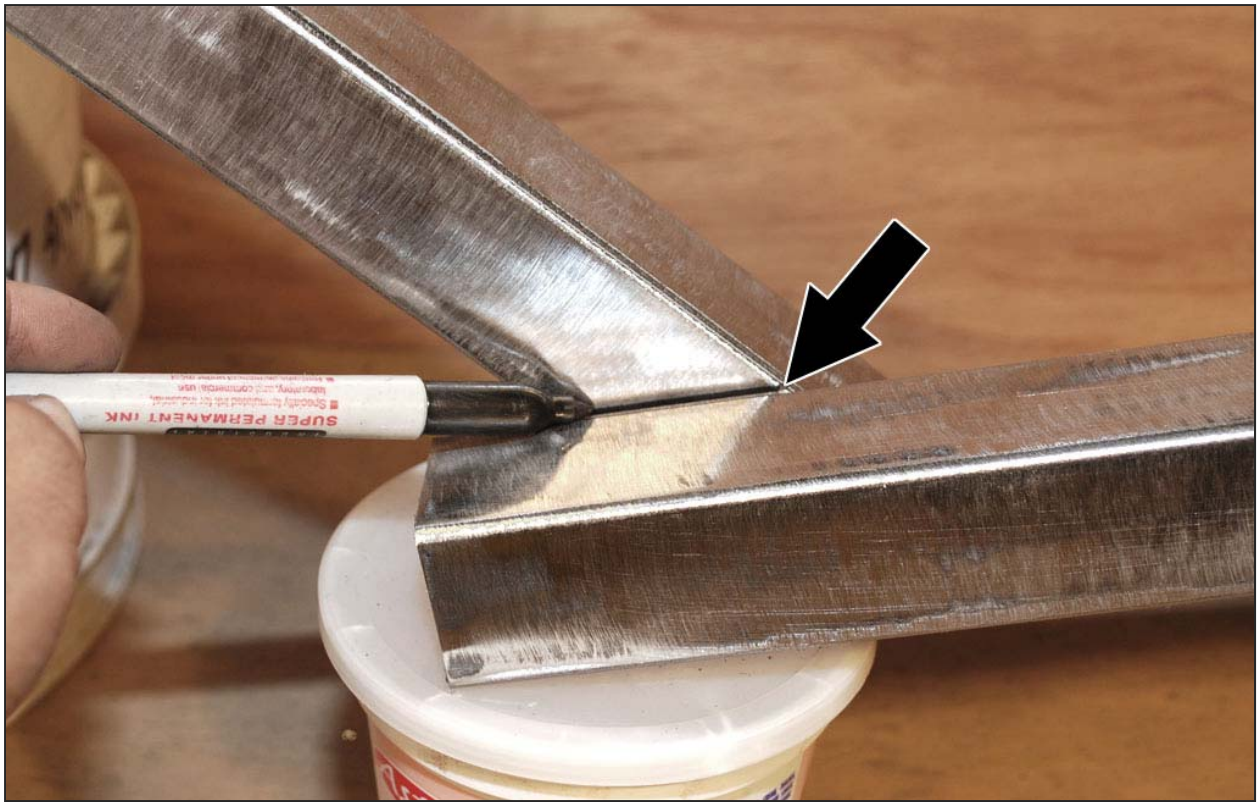

Figure 35 – Marking the seat back tube angle

Diagram 2 and Figure 37 show the final goal of the next few steps – a seat back tube of approximately 19 inches in length attached to the rear fork tubing and seat base tube at 45 degrees on both ends. The seat base tube is cut to an initial length of 14 inches as shown in Diagram 2, but will be cut later as you decide on how much room you need on the frame to sit. Your size as well as the type of seat will be part of the equation, so the 14 inch length is just a "safe" starting point.

Figure 35 shows how the seat back tube can be marked for cutting by drawing a line using the 45 degree seat base tube as a guide. Since the seat back tube was initially cut to a length of 20 inches, you should be able to set up all tubing, rear forks (with wheel installed) on the ground as shown in Figure 37 to mark the cut line. Remember to have a 26 inch rear wheel with a fully inflated tire installed when you set up your frame for cutting.

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Figure 36 – Leaving room for a frame gusset

Riders who weigh over 250 pounds should place a small triangular gusset between the small space formed by the 1 inch of seat base tubing extending past the seat back tube as shown in Figure 36. Again, this is only an option, and if preferred, the joint can be made in the same manner as will be shown for the front seat joint in steps 69 to 73.

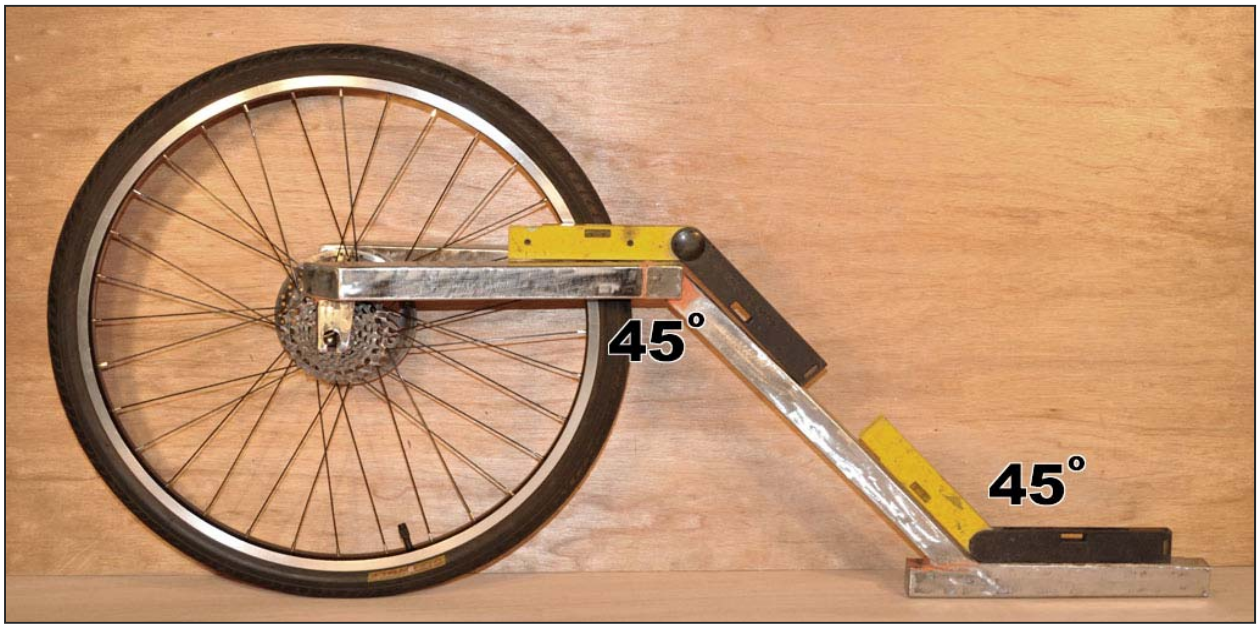

Figure 37 – Frame setup and alignment check

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With the two 45 degree angles formed between the 19 inch long seat back tube, the frame should sit on the ground as shown in Figure 37, with the seat base parallel to the ground. Depending on your tire, the angle of the rear forks may be slightly off parallel, but this is not all that important as long as the joint between the fork tubing and the triangular cutout does not have a huge gap. If you are using an extremely fat tire or decide to try a wheel size other than 26 inches, then you will have to either shorten the seat back tube or mess around with the triangular cut at the top of the seat back tube to make a joint suitable for welding.

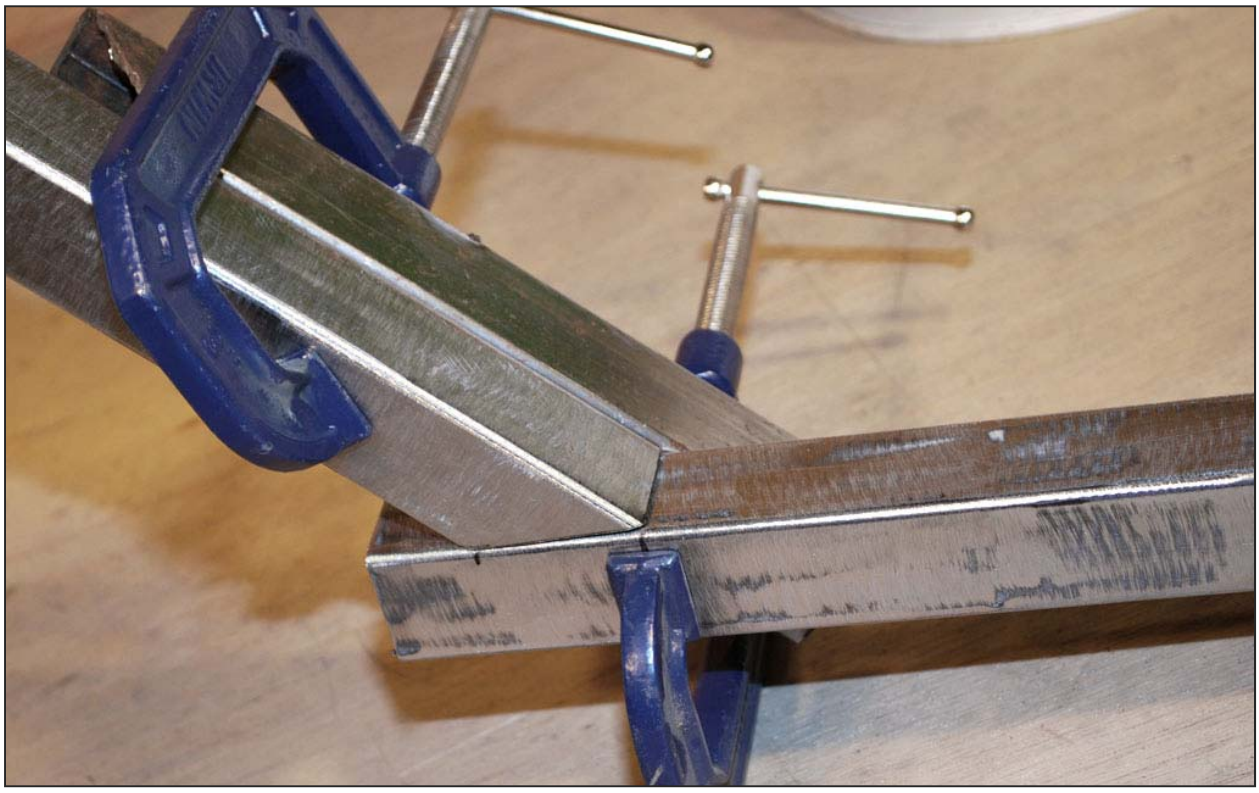

Figure 38 – Using a guide tube to hold the parts for welding

When welding a mono boom frame like this, it is important that all tubes are in line with each other so your front and rear wheels are perfectly inline. By clamping another straight tube or thick piece of angle iron to the parts to be welded, you create a jig that will force them into perfect alignment. But even with the jig holding the tubes in place, the order of welding becomes important to minimize distortion.

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Figure 39 – Start by making corner tack welds

Start by placing tack welds in all of the corners that are accessible to your welding rod and then check the angles one last time. Figure 39 shows the seat back tube placed about 1 inch from the end of the seat base tube all ready to be welded.

Figure 40 – The top and bottom are welded first

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To minimize side-to-side distortion, the top and bottom of the joints need to be welded first as shown in Figure 40, using the clamps and the guide tubing as a jig. Try not to weld the jig to the frame!

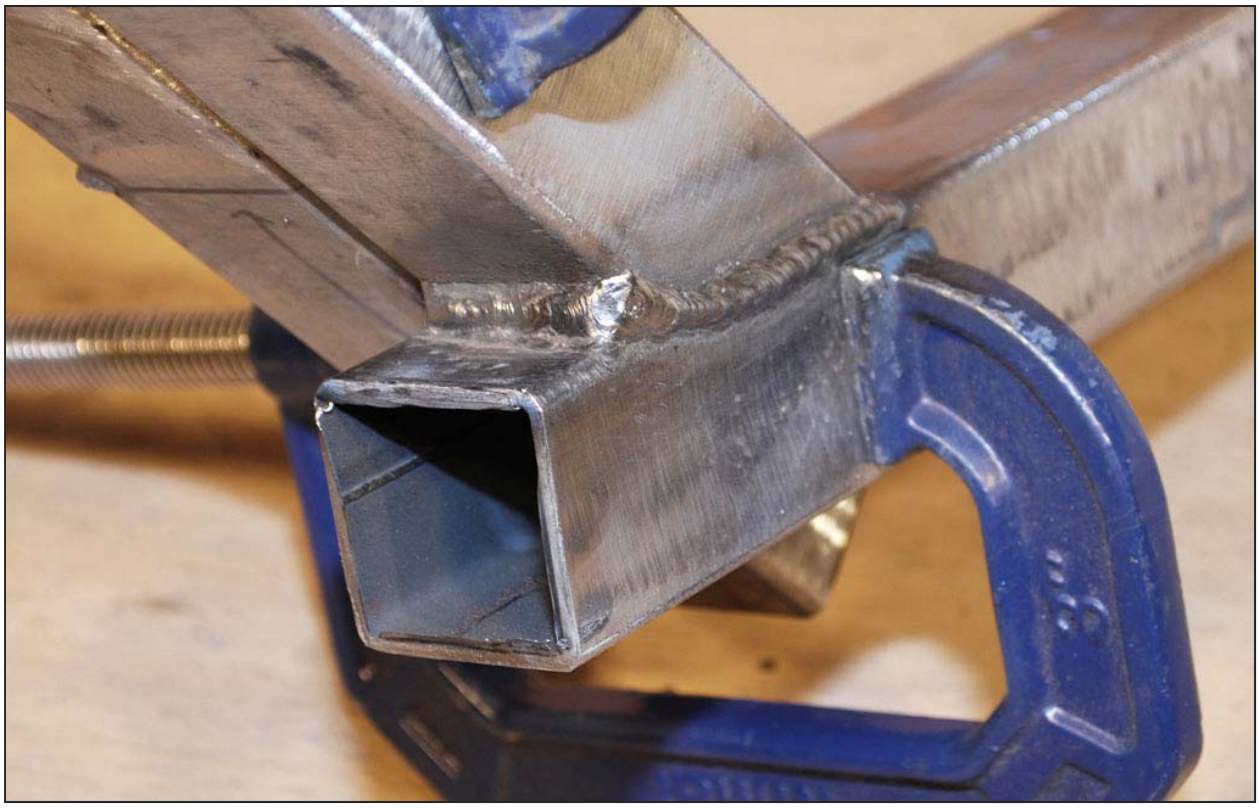

Figure 41– Welding the inside corner

The inside corner will be a bit more of a challenge to weld, and might take more than one pass to get fully filled. I had to make two passes to fill in all of the gaps (Figure 41) using my basic AC arc welder.

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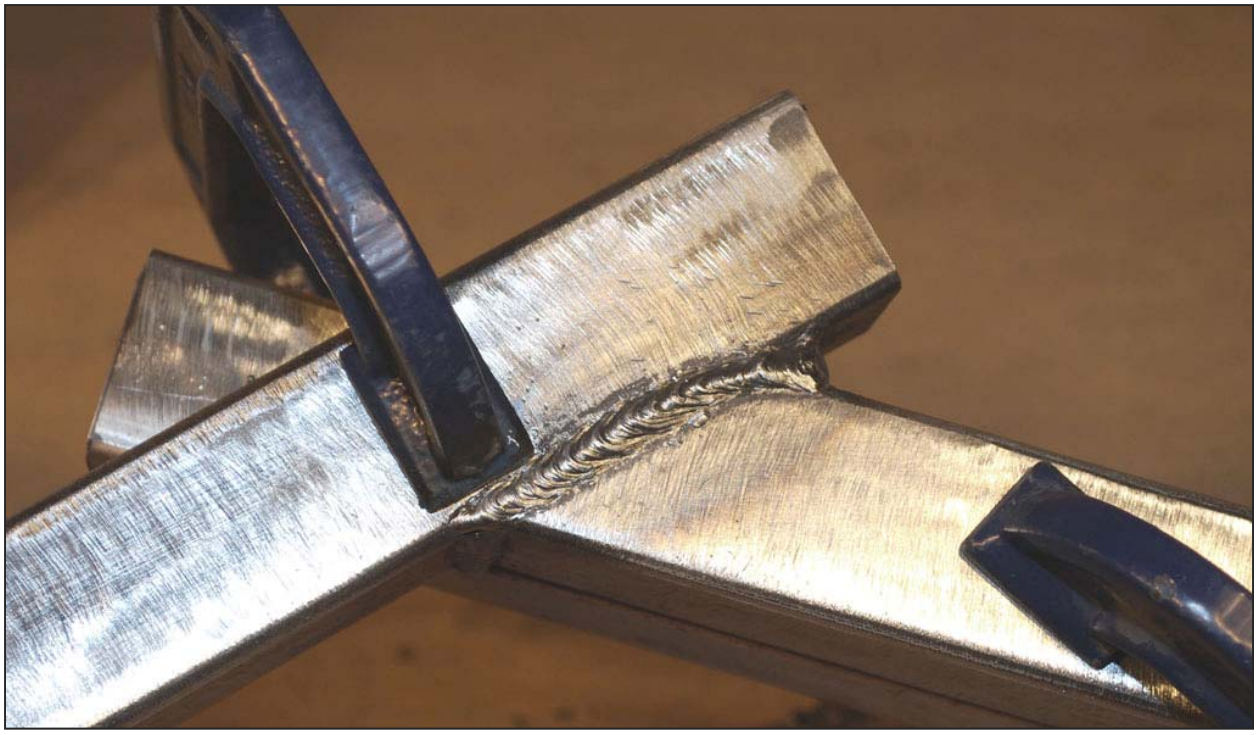

Figure 42– The sides of the joint are done next

The open side of the joint can be welded after the top and bottom have been welded as shown in Figure 42. You will need to remove the clamps to get to the other side, and clamping the welded side will be impossible, but that's OK, since the welded side will be holding the joint secure now.

Figure 43 – The seat back and seat base welds complete

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Since this joint is one of the most important structural joints in the frame, ensure that all holes are filled and that the joint is completely welded all the way around. If you are over 250 pounds, or don't fully trust your welds yet, you can add a triangular gusset behind the tubing where it sticks out past the seat back. Figure 43 shows the completed joint between the seat back tube and the seat base tube.

Figure 44 – Capping off the open center boom tube

To give the frame stiffness, the open end of the seat base tube must also be capped. As a general rule, all tubing will need to be capped, and is certainly worth the effort when making your final design look professional. A bit of scrap tubing was butchered for the 1.5 by 1.5 inch piece shown tack welded to the open tube in Figure 44.

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Figure 45 – End cap welded all the way around

When welding the end caps, you can turn down the current and just take your time going around the joint as shown in Figure 45. The goal is to leave as few gaps as possible so that the ‘repair” work after grinding the joint flush will be minimal.

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Figure 46 – End cap welded all the way around

A flap disc (sanding disc) is used to glean up the end cap as shown in Figure 46, leaving a smooth seamless joint that looks very professional.

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JOINING THE REAR FORKS

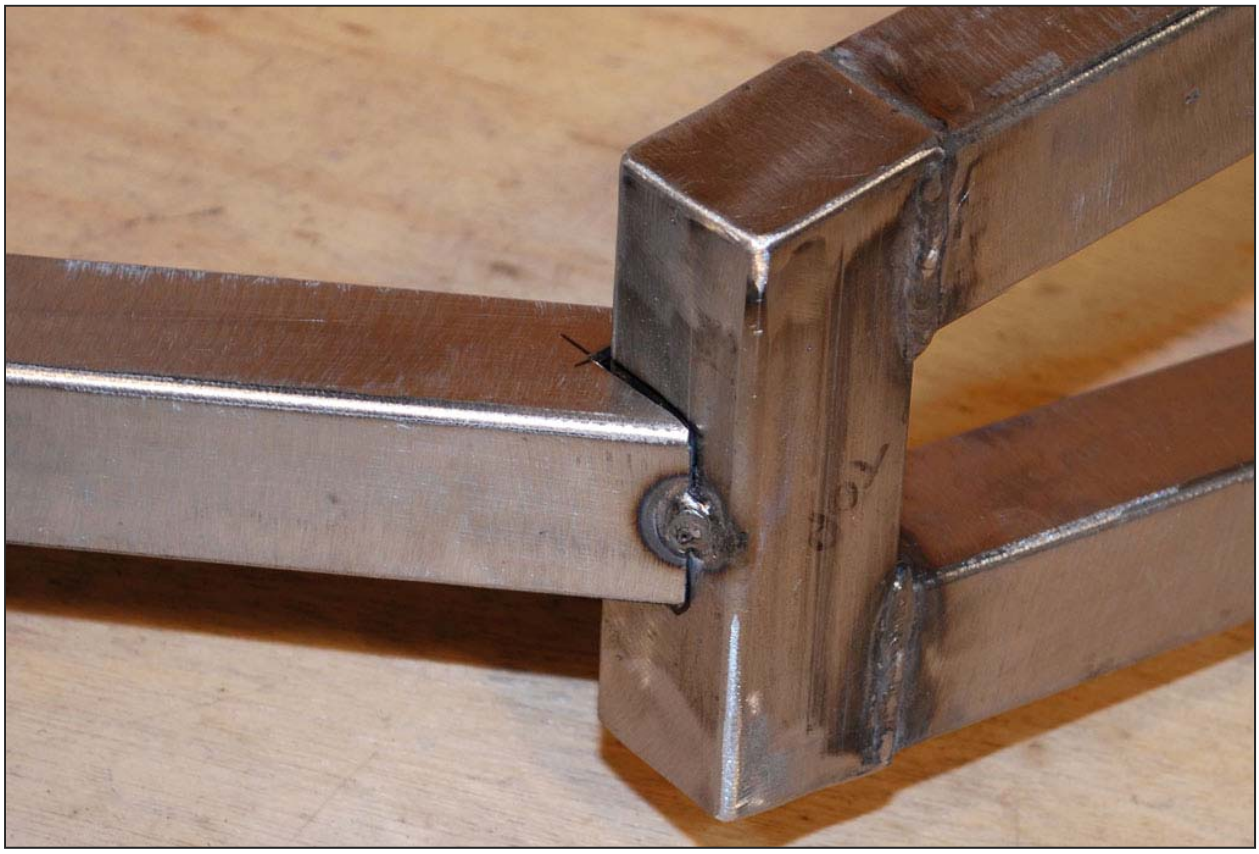

Figure 47 – Joining the rear seat tube to the rear forks

The next step is to weld the rear fork assembly to the top of the seat back tube as shown in Figure 47 so that it is in the center. I recommend that you add a single tack weld, and then place the frame back on the ground with a rear wheel installed just to ensure that the angles and alignment are correct.

The initial tack weld shown in Figure 47 can be made while you have the frame sitting on the ground with a wheel installed as shown back in Figure 37, but ensure to cover the rim and tire with a cloth so they are not damaged by welding spatter.

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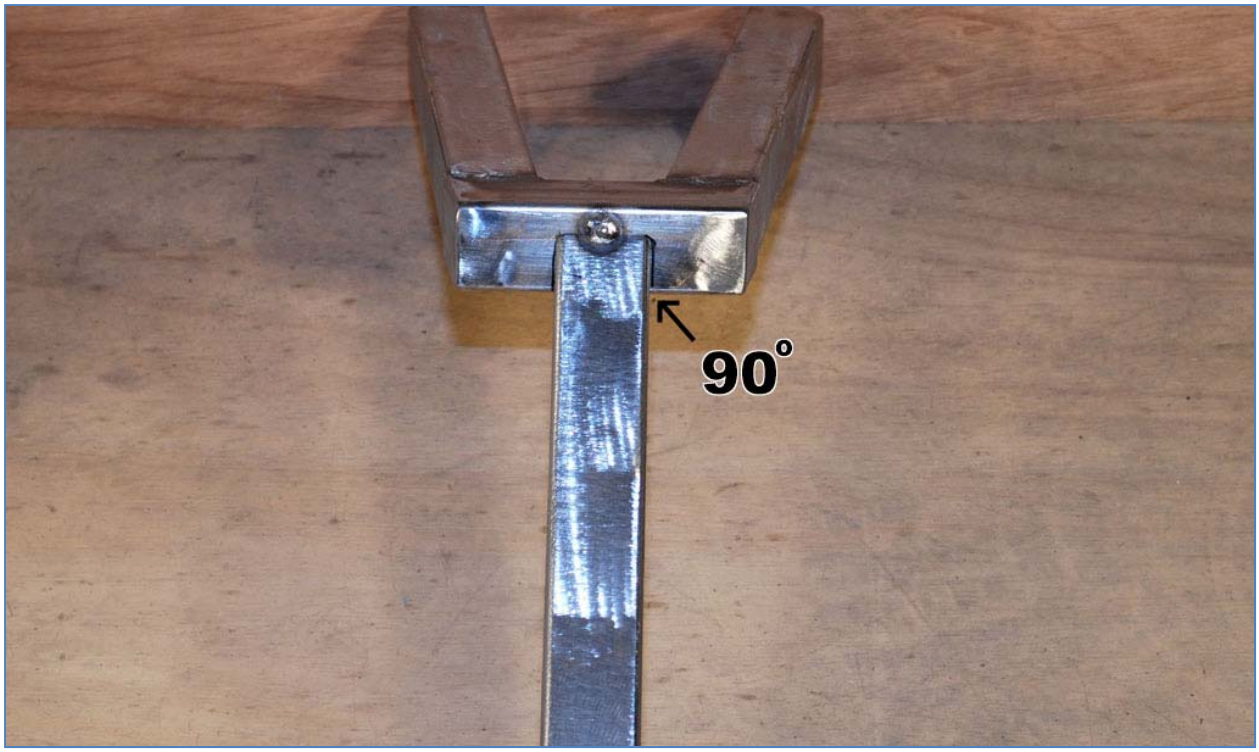

Figure 48 – Checking the side-to-side angle

With the top and bottom of the joint tack welded, check the angle between the small fork tube and seat back tube as shown in Figure 48, to ensure it is at 90 degrees. Installing your rear wheel or rim is another good visual aid to ensure that the wheel and frame tubing are perfectly in line with each other.

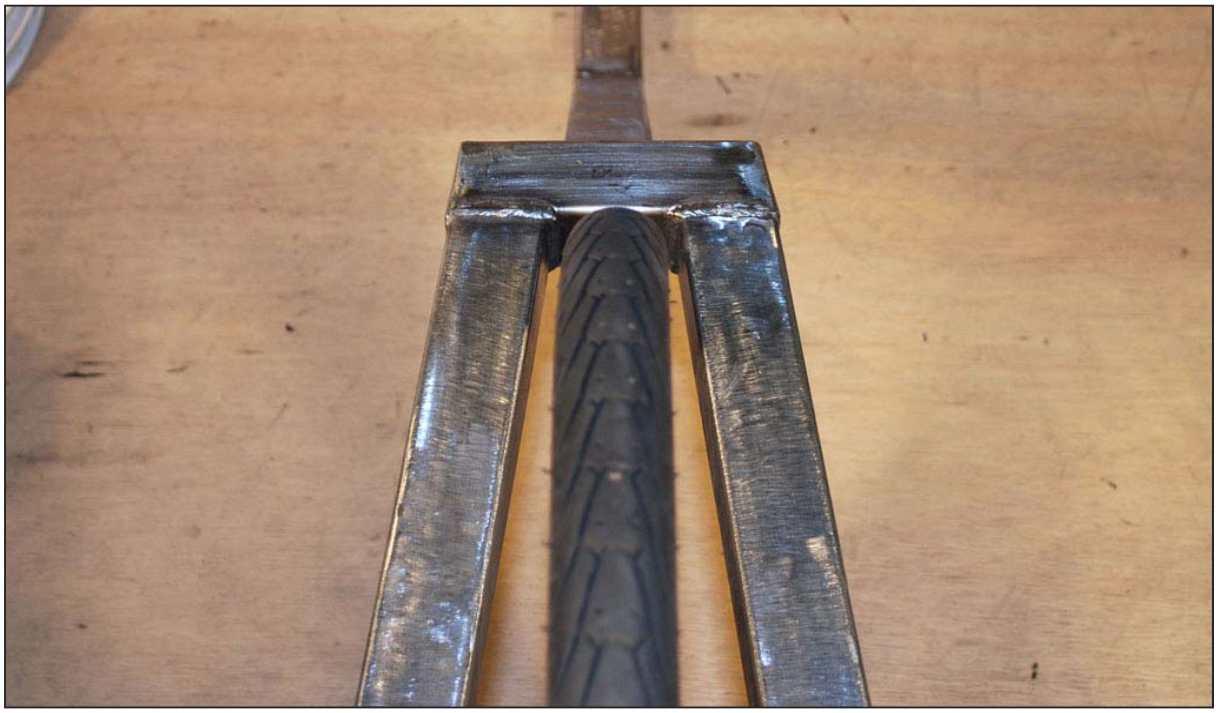

Figure 49 – Using the rear wheel to check angles

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To further check the angles, install the rear wheel and look down the frame as shown in Figure 49 to ensure that the wheel is perfectly in line with the rest of the frame tubing. Although, you can "tweak" the rear wheel in the dropouts later, it's best to make the frame as straight as you can for appearances. If alignment is way out, break one or both of the tack welds and try again. Another thing to check is that both dropout slots are equal, as this could send your cause your rear wheel to lean to one side as well.

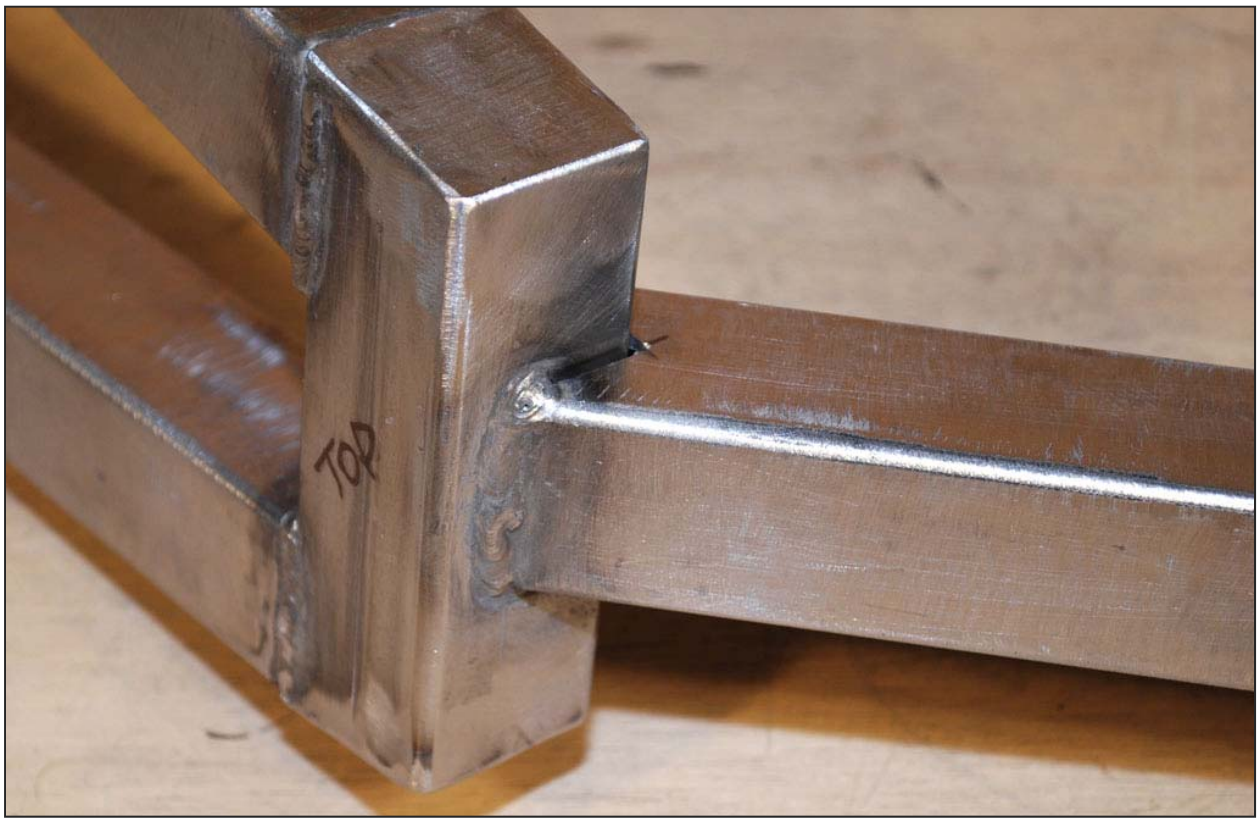

Figure 50 – Start at the top of the joint

Carefully remove the rear wheel so you can weld the top of the joint without disturbing the angles held by the tack welds. As shown in Figure 50, the top of the rear seat tube and fork assembly weld is done first, followed by the underside of the joint. You can't easily clamp and jig this weld, so check the alignment once more after the top of the weld has been made.

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Figure 51 – Welding the side of the joint

The sides of the joint will be completed after the top and bottom as shown in Figure 51. This area is another high stress point on the frame, so if you are concerned about your welding penetration or weight over 250 pounds, a few small triangular gussets can be added to give the joint more strength.

FITTING THE SEAT

Figure 52 – Making sure I have just enough room

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The Tomahawk has been designed to fit riders who would normally have issues with standard productions lowracers, so clearances between the seat, frame, and front wheel need to be tight. If you are shorter than 5' 8", then it will be important to get the front tire as close to the frame as possible and to keep the seating space down to the absolute minimal amount needed. Having to move the cranks in the path of the front wheel is something that should be avoided at all costs, so read ahead and take your time with the seating measurements to follow.

First, you need to find out the absolute minimal space that you will need between the front seat tube and the back of your seat. This will probably be a lot less space than you might think, typically, between 6 and 8 inches. It is fine to have that front seat tube close to your body "parts" because you will always be pushing on the pedals, holding your back firmly against the seat. The incline of the seat also keeps you there.

To determine your minimal seat space, place a board on a 45 degree angle as shown in Figure 52 and then drop a tube between your legs at an opposing 45 degree angle. You also have to factor in your seat padding material, so either make your seat boards now to add padding, or remember to add the lost space that will be taken up by the thickness of your padding material. I found that I was just fine with 6.5 inches of seat base space, and since my seat foam is only 1 inch thick, 7.5 inches was my magic number as shown in Figure 52. Remember, if you are shorter than 5' 10", get that front tube as close as you can without having it become uncomfortable.

Figure 53 – Matching the rims for esthetic reasons

To complete the front of the Tomahawk frame, you will need to have a front wheel, front fork, and a matching head tube. Since the rest of the frame is built around that part you plan to use, it is important to source them now, as slight variances in tire diameter may be enough to cause a problem if you are working to keep the clearances as tight as possible. Figure 53 shows my matched wheel set, which includes a rear 26 inch rim with a disc brake and a 20 inch radial spoked front wheel. You can use any

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type of braking you like on this project. I used a disc and a pad brake to show how they are both installed and set up.

Often, a quality racing wheel is a difficult thing to find in a 20 inch size, and disc brakes on a 20 inch wheel are even less common, so you may want to consider building your own wheel as I did. The rim I started with was called a “BMX race rim” and is a new style of BMX wheel that makes freestyle bikes much lighter. I added a good quality hub and then built the wheel using a radial lace pattern, which is an easy way to build up a wheel if you don’t require a disc brake on the hub.

Figure 54 – Finding a suitable front fork

Often, it can be a challenge to find a high quality 20 inch front for a lowracer, especially if you want to include cantilever brakes. Department store kid’s bikes have poorly made front forks, and BMX bikes have heavy forks that are just too “beefy” for a bike like the Tomahawk. The good news is that you can make a perfect custom front fork out of any 26 inch or 24 inch fork just by doing a little surgery on it.

Figure 54 shows my 20 inch front wheel placed into a 26 inch front mountain bike fork with cantilever brake studs included. Obviously, the fork is much too tall and the brakes will never line up, so the legs have to be cut and re-welded to make them shorter. This is any easy operation that will only take less than an hour to complete.

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FRONT FORKS

Figure 55 – Determine the optimal fork length

What counts is that your brake pads line up properly with the rim, so you need to measure the gap as shown in Figure 55 by placing your tape measure from the rim edge center to the brake pad center. Your distance will likely be similar to mine which is 2.5 inches of fork leg to be removed, but check with your actual rim and brake lever to make sure. Brake pads offer some up and down adjustment, so place them in the center when measuring so you can easily adjust for slight errors later.

Figure 56 – Mark the fork tips for cutting

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To shorten a front fork, mark the length to remove at the tips, just above the dropouts as shown in Figure 56. This part of the fork has a thick wall and is very easy to weld with higher heat for good penetration. The key is to cut the section out of the same place on both legs, so a bit of tape around the tubing can be used to make a nice cutting guide. Being tapered, a tube cutter cannot be used, so a hacksaw or zip disc will be needed.

Figure 57 – Removing the extra length

Carefully cut along the tape edge or a marked line so that the same amount of fork leg is removed from the same place on both sides as shown in Figure 57.

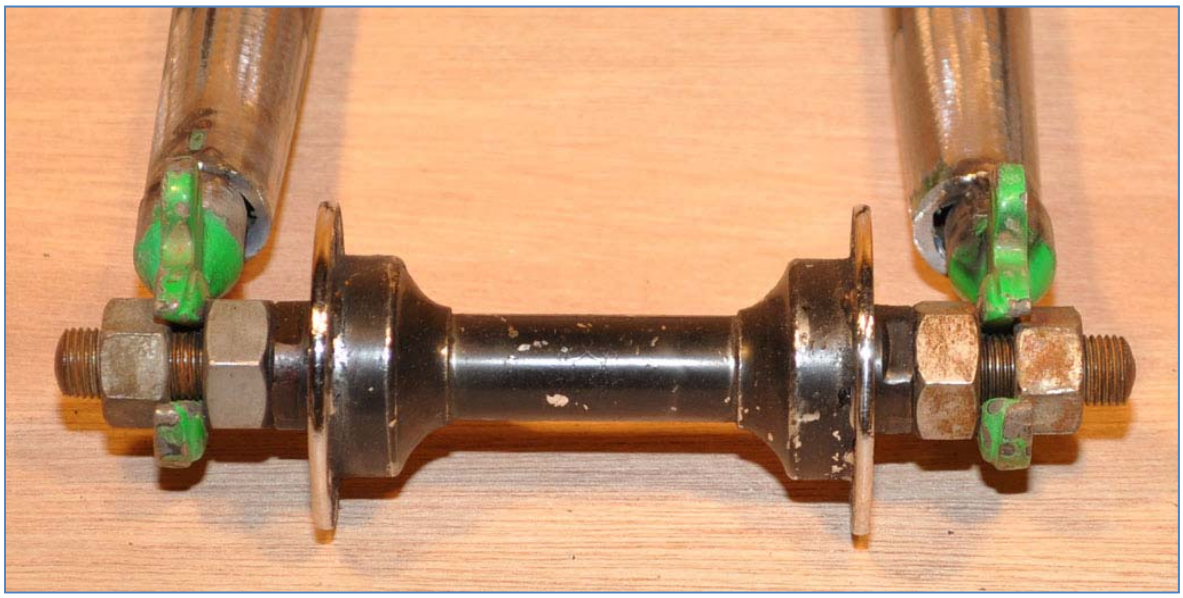

Figure 58 – Using a front hub as an alignment guide

After cutting a section from the fork legs, the tips will need to be re-welded to the legs to create the new 20 inch forks. As you can see in Figure 58, the two sections of fork tubing have different widths due to the taper, but the gap is so minimal that is easy to fill with weld metal. Use a front hub to hold the dropouts so the fork tips can be aligned for tack welding by placing the forks and hub flanges on a flat surface.

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Figure 59 – Checking brake pad alignment

After you have a few good tack welds holding the fork tips in place, check the brake pad alignment as shown in Figure 59 to ensure that the pad will strike the rim in the correct position.

Figure 60 – The completed shortened forks

Weld all the way around the joint, using as much amperage as you can without burning a hole as to ensure good penetration. The thicker wall at the fork tips makes welding the joint and filling the small gap easy. The completed high quality 20 inch forks are shown in Figure 60 after completing the shortening surgery.

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HEAD TUBE

Figure 61 – Finding a suitable head tube

To complete the Tomahawk frame, you will need your front forks, front wheel and a head tube to calculate the length and angle of the front seat tube. The most important factor to consider is how you will fit on the bike, so the rest of the building process is based on the actual parts you plan to use, not a strict set of measurements or angles. You will need a suitable head tube with the included bearing hardware as shown in Figure 61. If the head came with the forks, then you are all set, but it is not a problem to mix and match parts, and shortening a head tube is a simple process.

Figure 62 – Grind away the excess tubing

Trim away any excess frame tubing by first using a heavy grinder disc to cut as close to the head tube as you can. When you have the metal ground away as shown in Figure 62, a flap disc is then used to clean up the last of the frame tubing, as well as remove the paint from the head tube for welding.

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Figure 63 – Grind away the excess tubing

To shorten a head tube that is too long for a fork stem, insert all of the fork hardware (including bearings) and then mark a line as shown in Figure 63 so you know how long the head tube should be. Also shown in Figure 63 are the results of using a flap disc to clean the last of the frame tubing and paint from the head tube shell.

If you had to shorten your head tube, you will need to run a round file around the inside of the cut end to make a slight taper to allow the cups to fit properly. Just look at the other side to see how much is necessary.

Figure 64 – The completed front fork set

Once all of your fork hardware is reinstalled into the head tube as shown in Figure 64, give the forks a spin to ensure you have the bearings installed correctly. If there is any resistance, either the bearings are

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upside down or the cups and races are not a matched set. Like many mechanical things, there are several "standard" sizes available to make things even more confusing!

SEAT FRONT TUBE

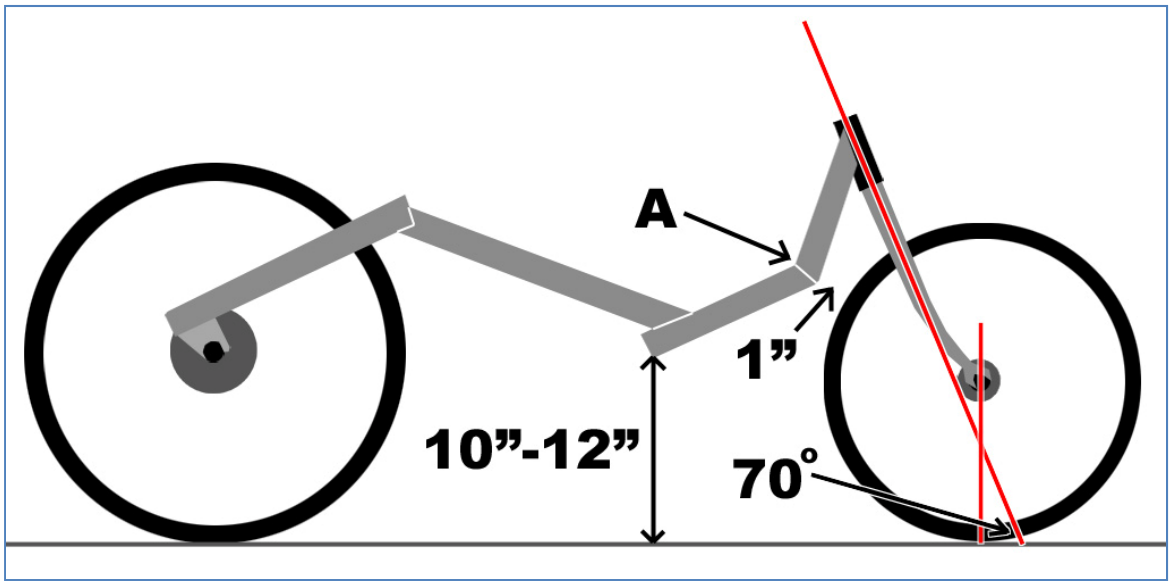

Diagram 3 – The front of the frame

The front seat tube will join the head tube to the rest of the frame, and is based on the angle of the head tube and the position of the seat base tube. This tube is calculated by placing the frame up off the ground so that the lowest point under the frame is about 10 inches to 12 inches off the ground. This part of the build depends on how far you can reach, and if you are not a tall rider, every inch is going to matter if you don't want the crank arms to strike the front tire when pedaling. Take your time here and plan ahead.

Diagram 3 shows the frame being held off the ground to a height of 10 to 12 inches, and the head tube placed in such a way that it forms a 70 degree angle with the ground (the longer red line). The shorter red line shows that there is about 2 inches of trail, which is the distance between the head tube line and the forward offset of the front axle. Also shown is the 1 inch (or less) clearance between the front tire edge and the frame tubing joint. Being a shorter rider myself, I needed to keep clearances very tight and only have ½ inch of clearance between my tire and the frame.

The angle indicated at point (A) in Diagram 3 is actually unknown, as both the length and angle will depend on your leg length and the parts you are using. The following steps will explain how to get this tube cut so that it fits your requirements.

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Figure 65 – Setting up the front of the bike

A shown in Diagram 3, set up your frame so that the underside is held up about 10 inches from the ground. Ten inches is the starting point, and if your legs cannot reach the pedals after the following steps, you may need to increase the height of your seat, but only do so as a last resort. As you lift the seat, you also relax the angle and will need to compensate by padding the top of the seat or tilting the seat forward later. Taller riders with longer legs have nothing to worry about here, and may even choose to lower the seat somewhat. Again, the goal is to fit the frame to your requirements, so set it up as shown in Figure 65 and work from there.

Also shown in Figure 65 is the head tube being held at an angle of 70 degrees to the ground by the new front seat tube. An adjustable square with a long straight rod taped to one side is a great tool for setting up head tube angles. The 70 degree angle can be a few degrees out, so don't worry about exact precision here, just try to get as close as you can.

As for the actual length of the new front seat tube, start with a length of tubing approximately 14 inches long, as this will be more than you need unless you have made radical design changes.

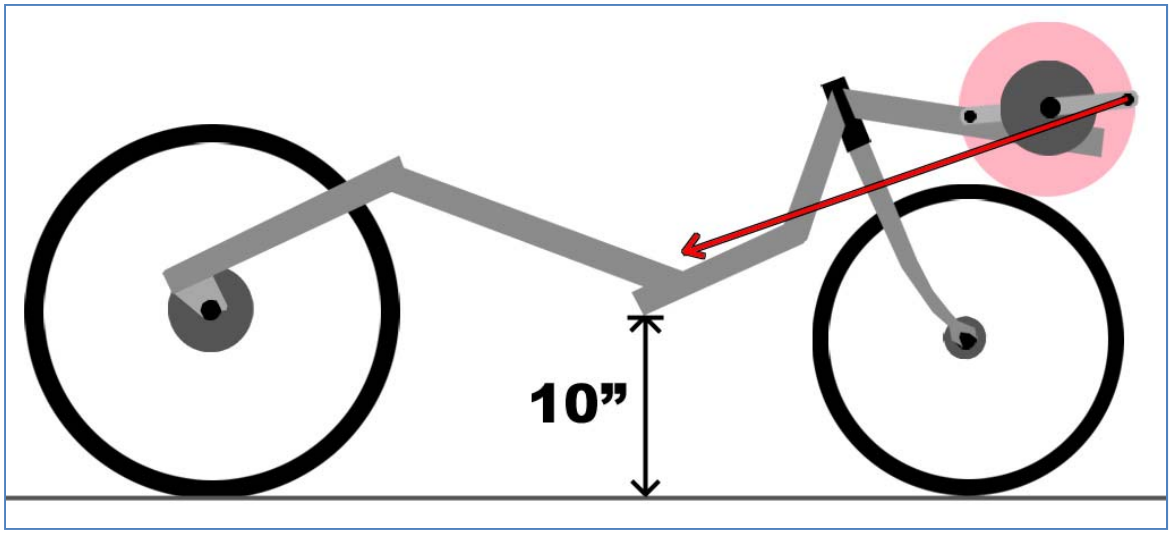

Diagram 4 – The desired goal if your legs can reach

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Diagram 4 shows the ultimate goal of the Tomahawk design, having a 10 inch ground clearance and no crank-to-front wheel interference (show as the red circle). The red arrow indicates the distance you will need from the back of your butt on the seat to the furthest reach of a pedal, and this distance is found by sitting snug up against a wall with your shoes on as a helper measures from the wall to the underside of your shoe. This distance (your recumbent inseam) is very important, and will determine the geometry for the rest of this project

My recumbent inseam was 34 inches, and I had very little room to spare. My front wheel was only ½" away from the frame, and my crank arms miss the front wheel by less than that! If I had legs that were only an inch shorter, I would either have to raise the seat and crank boom, or go to a smaller 16 inch front wheel. If you find that your legs might not reach, then you have to decide between a higher seat and crank, or a smaller front wheel diameter. Finding quality 16 inch rims and tires might be difficult, but then again having the seat higher than 12 inches reduces some of the point of the lowracer and may make it difficult to stop with both feet flat on the ground.

Like I said, take your time here and work things out well before cutting any tubing. If you end up with crank strike, your bike will be a death trap unsuitable for street riding.

Figure 66 – Finding the perfect bottom bracket height

Taller riders with an inseam of more than 36 inches will have no problems at all placing the bottom bracket in front of the wheel without crank strike, but if you are like me, then some careful planning is necessary. The composite diagram shown in Figure 66 gives you an idea of how close the clearances will be if your inseam is close to mine, at around 34 inches. Again, this "recumbent inseam" is the distance from the corner of your seat (include padding) to your furthest foot reach. The red circle shown in Figure 66 is the crank strike zone, and this must be avoided at all cost.

The blue line in Figure 66 shows the optimal height for the lowest rotation of a crank, about the same height as the top of your seat padding. I was lucky and just managed to get this height by keeping the front wheel and crank strike zone not even half an inch away from the front tire! If you can't reach, you have to start raising the bottom bracket to get the crank higher up, but you might also have to do the same to the seat base, or end up looking at our feet while riding. Having the lowest point of the crank 3 or 4

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inches above your seat is not too bad, and some lowracers have this position already, but if you raise your feet too much, you will eventually block your own view and ruin your comfort zone.

If you are pushing for all the room you can find, then consider making a mock frame out of some 2 x 2 lumber and make sure you have what you want before committing to any tubing cuts. If you are an Amazon giant, then just motor ahead with no worries!

FRONT END SET UP

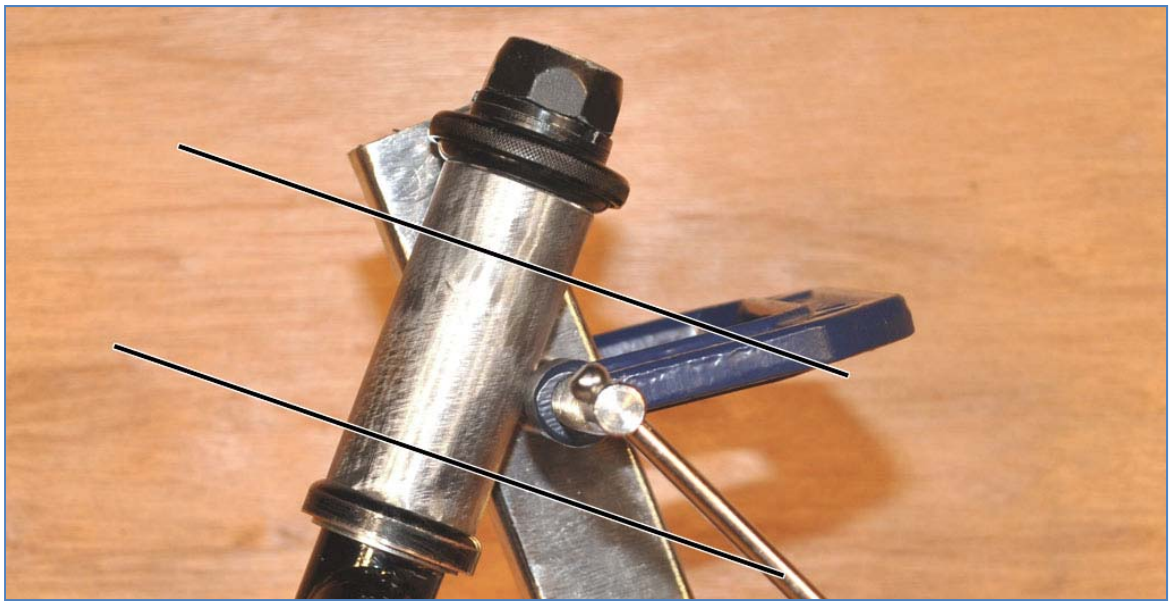

Figure 67 – Setting the 70 degree head tube angle

Figure 67 shows the position of the front seat tube as it meets the head tube, so that there is at least half an inch of head tube extending past the underside of the frame tubing so you can make a good weld. My head tube was 3.5 inches tall, which made it pretty much equal on the top and bottom. A taller head tube is just fine. The head tube is resting on a clamp and is set up at the required 70 degree angle.

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Figure 68 – The front seat tube clamped in place

Set up the frame and front end as shown in Diagram 4, clamping the new front seat tube to the frame as shown in Figure 68. Being 14 inches long, it will extend past the head tube and down into the seat base tube, but this is good as it allows the new tube to be clamped to the seat base tube as shown in Figure 68.

Do not mark or cut any tubes until you have determined your recumbent inseam and figure out if you can extend your leg from the seat corner to the furthest rotation of the crank arm. Diagram 4 and Figure 66 are very important.

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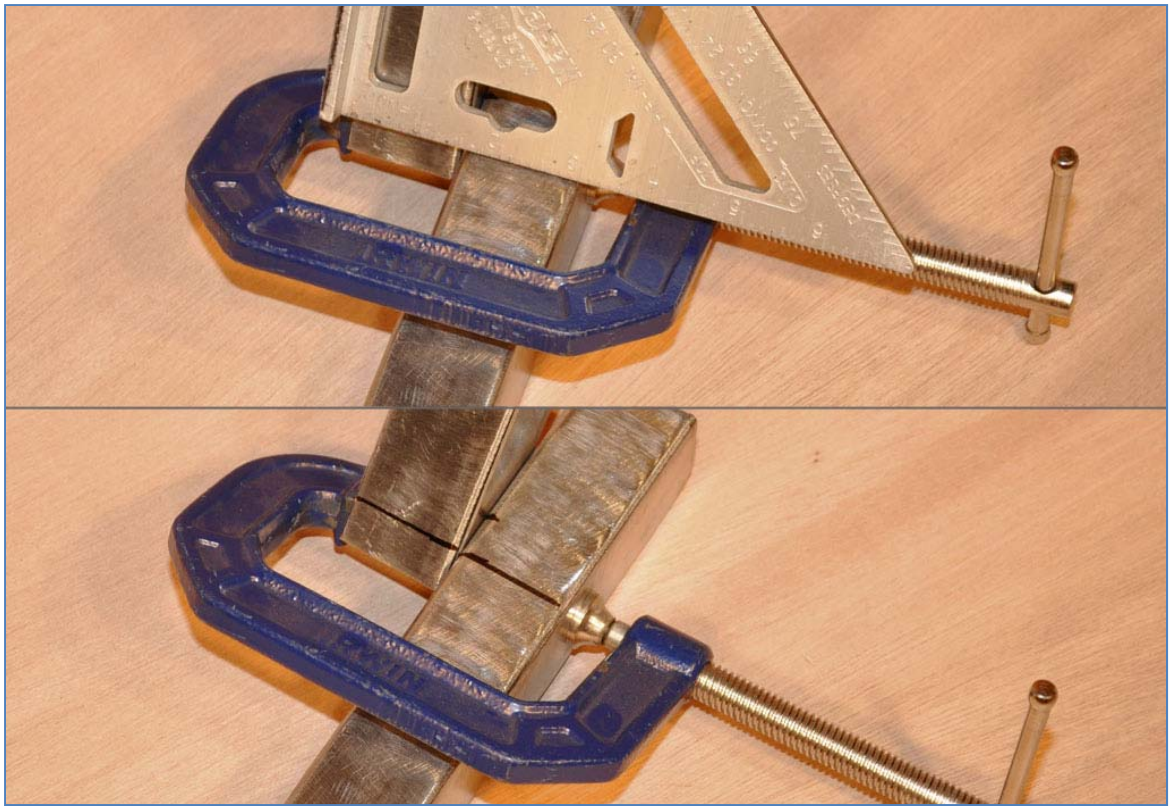

Figure 69 – Marking the top point for the angle cut

Once you have worked out all of your leg and crank clearance issues, tighten up the clamp that holds the new seat front tube to the seat base tube to lock the angle in place. You can then transfer a line across the top of the top where they intersect as shown in Figure 69. This is how you are going to get the angles marked for cutting without having to even know what they are. You could also measure the angle using an adjustable square or angle finder, if this is your preferred method.

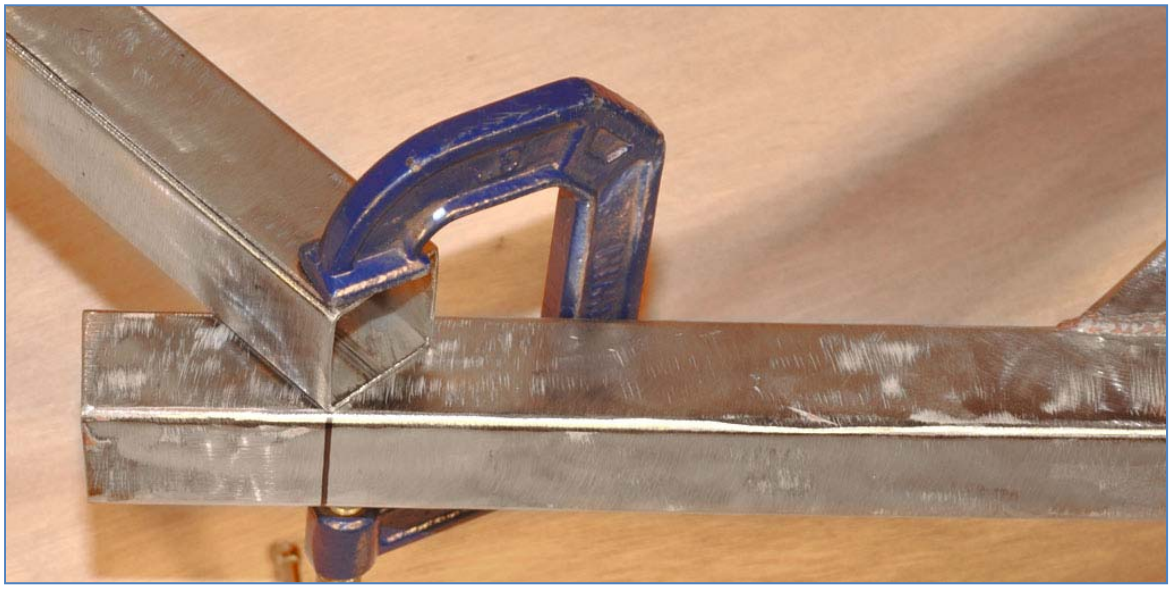

Figure 70 – Marking the bottom point for the angle cut

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The bottom side of the tube is also marked where the corners of the two tubes intersect as shown in Figure 70. These two lines allow cuts to be made that will copy the angle with very little chance of error.

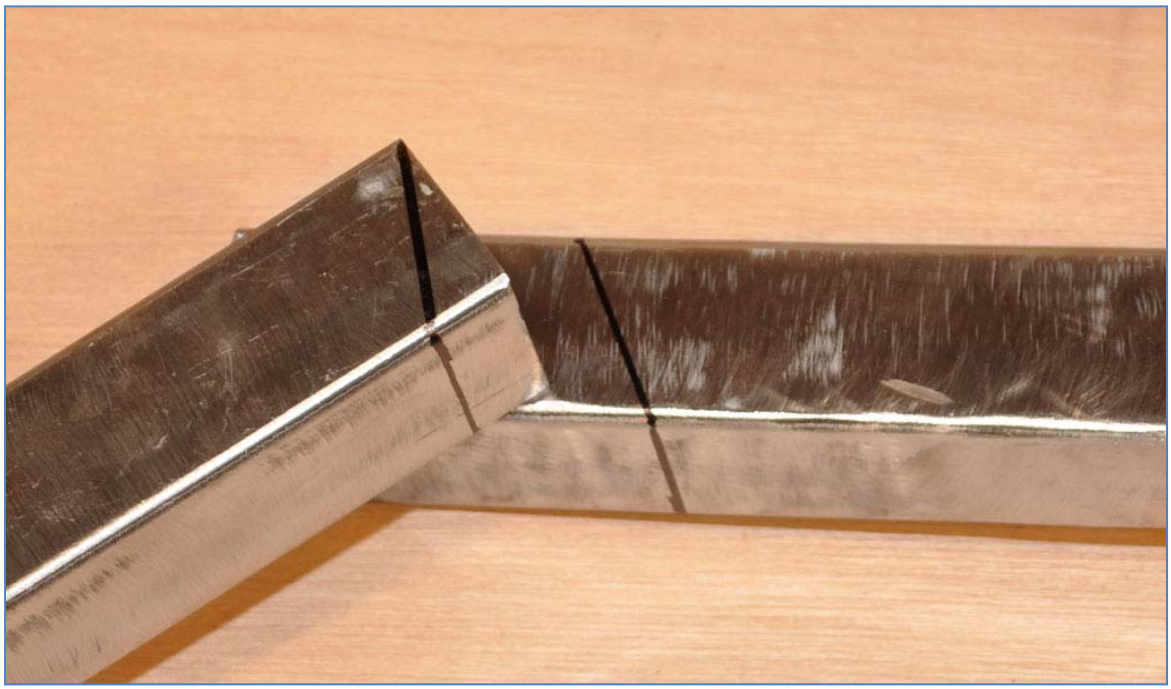

Figure 71 – Joining the lines to make the angles

Once the top and bottom intersection points are made as shown in Figure 69 and 70, the lines on the side can be made by simply connecting the corners. The resulting cut will make the same angle that the tubes were placed at when you marked the lines. An adjustable square is always a good backup, just to double check your work.

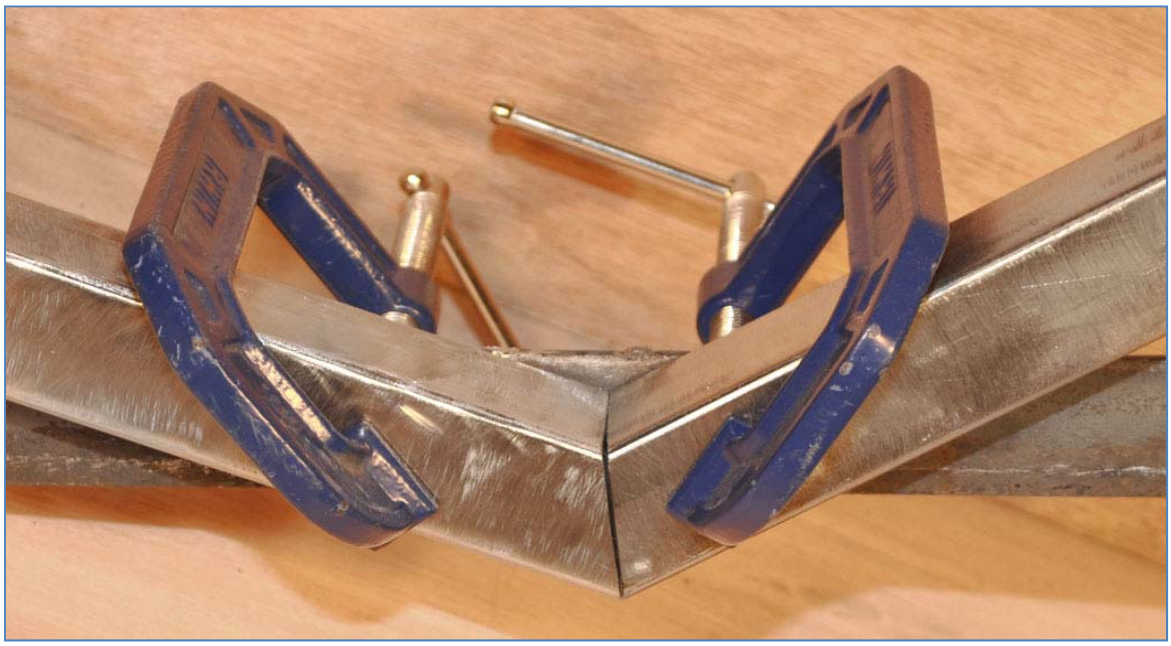

Figure 72 – Setting up the joint for welding

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Once you have made the angle cuts for the new front seat tube and the bottom seat tube, clamp them together for wielding using the same method as before, shown in Figure 72.

Figure 73 – Weld the top and bottom side first

When welding a single boom frame, all welds follow the same order, starting with the top and bottom and then completing the sides of the joint. Figure 73 shows the bottom of the front seat tube and bottom seat tube joint completely welded.

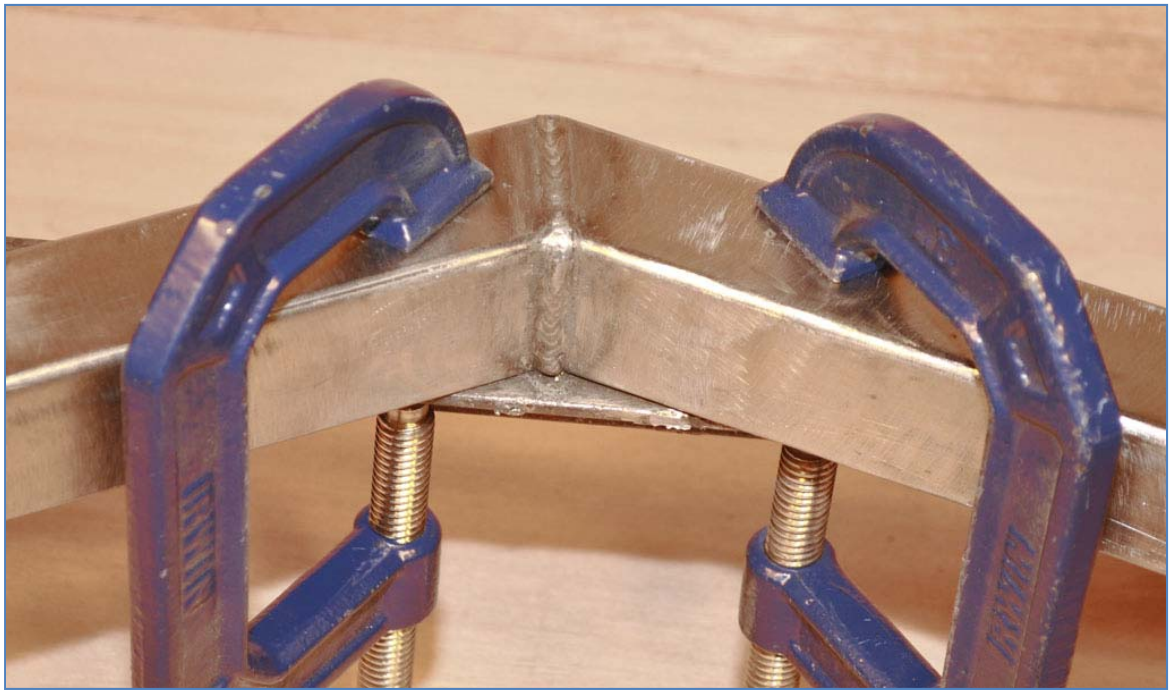

Figure 74 – Weld the sides of the joint last

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After completing the top and bottom of the joint, weld the one open side of the joint not covered by the jig as shown in Figure 74. You can then release the clams and complete the other side of the joint safely.

Figure 75 – The main frame completed

After completing the front seat tube welding, you will have most of the Tomahawk frame completed. Figure 75 shows the current state of the frame after welding.

INSTALL HEAD TUBE

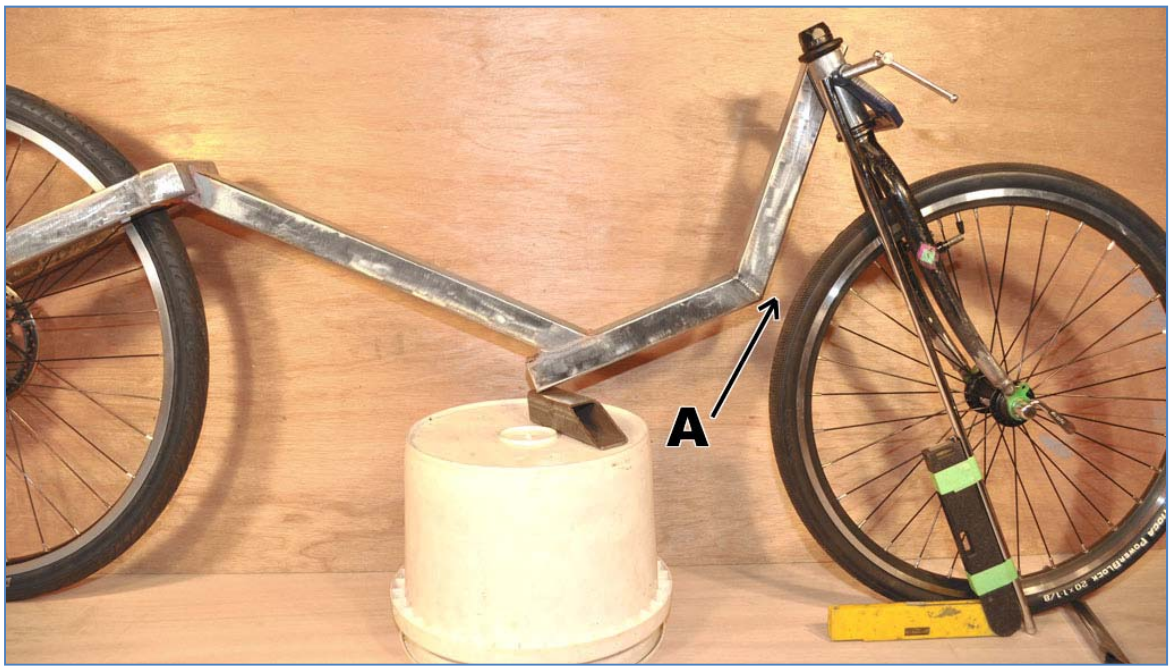

Figure 76 – Setting up the head tube for marking

Set up your frame using the same ground clearance that you had earlier and then place the head tube at the required 70 degree angle, clamping it to the top of the front seat tube as shown in Figure 76. Add half an inch to the clearance you require shown at point (A) in figure 76 as this will be lost as you cut the fishmouth for the head tube joint in the next few steps.

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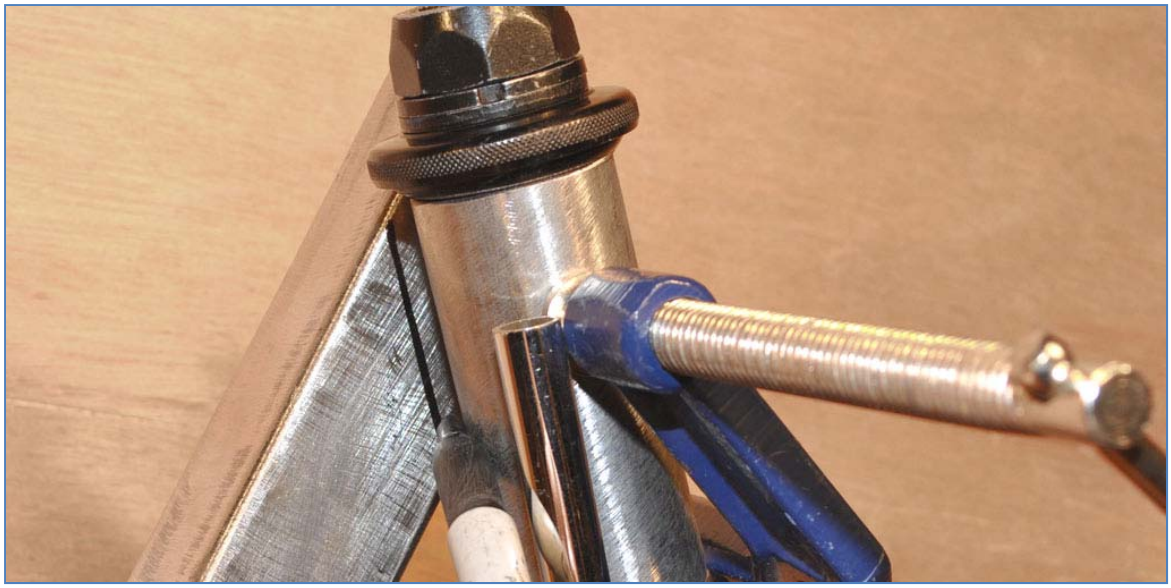

Figure 77– Marking the head tube angle

Once you have the head tube set up at 70 degrees and added half an inch for tire to frame clearances, carefully draw a line along the edge of the head tube to mark the top of the front seat tube for cutting as shown in Figure 77. Remember that the head tube needs to extend past the bottom of the tube about half an inch as shown earlier in Figure 67. The length of head tube extending past the top of the square tube is not important.

Figure 78 – Marking the fishmouth cut

The head tube will be welded to the end of the front seat tube at the required 70 degree angle, so two fishmouth cuts must be made to conform to the round tubing as shown in Figure 78. Using the actual head tube or a piece of round tubing of the same diameter, mark the top and bottom so that the area to be

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ground begins at each end corner. A line is drawn half an inch in from the end of the tube to ensure that the fishmouth does not pass this zone. You will probably be well inside the safety line.

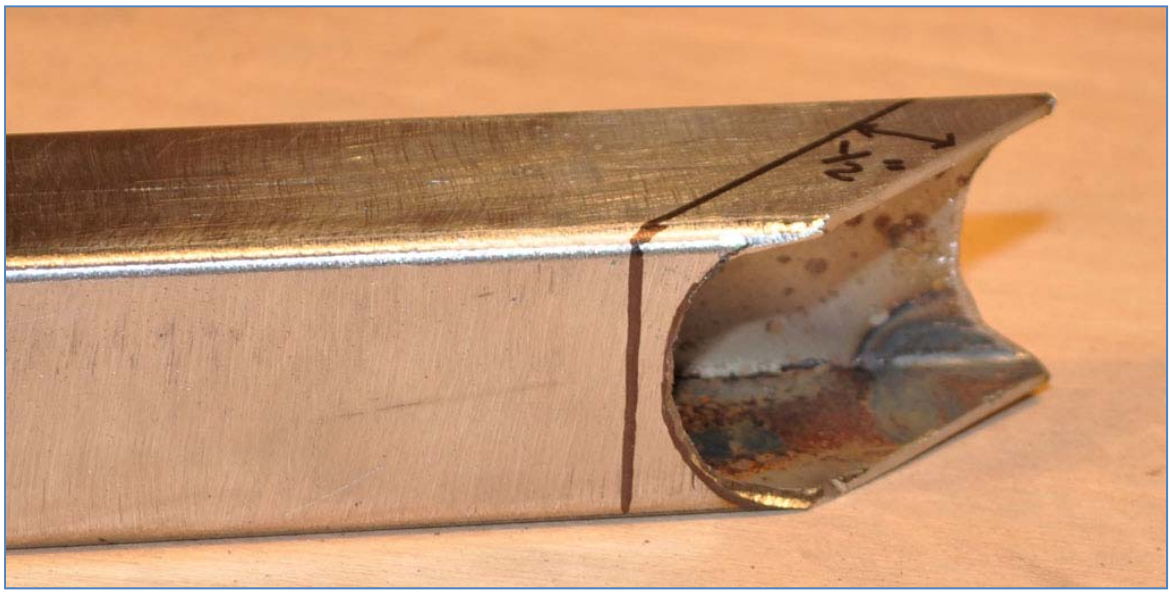

Figure 79 – Completing the fishmouth cut

The completed fishmouth cuts are shown in the top and bottom of the tube in Figure 79. Try to make them both the same depth so your head tube angle is very close to the 70 degrees. Grinding out a little less at first and then working your way into the tube a bit at a time is a safe method that will reduce the possibility of cutting too much out.

Figure 80 – Check the head tube angle

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The head tube angle should be checked by setting up the frame once again before completing any welds. If you need to adjust one of the fishmouth cuts, be very careful not to overdo the correction, or you will end up in a cycle that could put your cutting over the safety mark. Figure 80 shows the head tube resting in the fishmouth at the required 70 degree angle.

Figure 81 – Checking the head tube alignment

To ensure that the head tube is in line with the frame as well as being at the approximate 70 degree angle, a length of straight angle iron can be place over the front edge of the head tube as shown in Figure 81 so you can compare it to the rest of the frame tubing. This will ensure that your front and rear wheels are in line with each other. Using the actual forks and front wheel for an alignment check is also a good idea, but you will need another tack weld before you can install the forks. For an alignment check using front forks, you don't need the cups installed.

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Figure 82 – Tack weld the underside of the head tube

Once you have checked both the 70 degree angle and inline alignment of the head tube, place a good tack weld on the top of the joint as shown in Figure 82 so that you can continue to check alignment, making small adjustments by tapping the head tube with a hammer if needed.

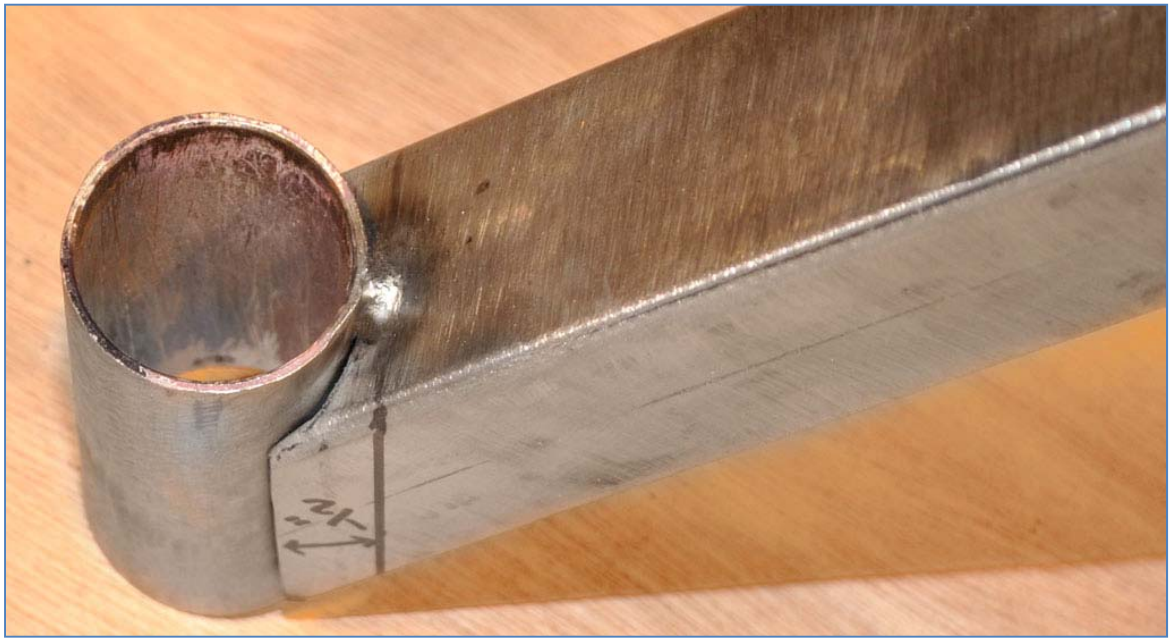

Figure 83 – Tack weld the underside of the head tube

Once you have confirmed the 70 degree angle and inline alignment of the head tube one more time, place a good tack weld on the underside of the joint as shown in Figure 83 to lock the position for welding.

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Figure 84 – Complete the head tube welding

The head tube welding is completed in the same order as the rest of the frame tubing welds, starting with the top and bottom and then completing the sides of the joint. Figure 84 shows the completed head tube welds. You should have a set of head tube cups installed when you weld as this will help keep the round tube from distorting under the head. Use an old set of cups if you have them.

Figure 85 – Checking the clearances

Figure 85 shows how tight the clearance between the front tire edge and frame tubing will be on my Tomahawk, only half an inch! I doubt I could run a larger tire now, but at least I can adjust the cranks for

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my inseam an inch either way without having to worry about the dreaded crank strike problem. All high performance racing machines have tight clearances, so all is well!

Figure 86 – The Tomahawk rolling frame

Add your wheels and you now have a rolling frame! Most of the hard work is done, so the rest of your build will be smooth sailing. At this point, you need both wheels installed with fully inflated tires. Also, install only the lower head tube bearing as this will allow you to tighten the top bearing race and hold the front forks in the straight ahead position, which will make it easier to stand the bike up for the next few steps.

MAKING A SEAT

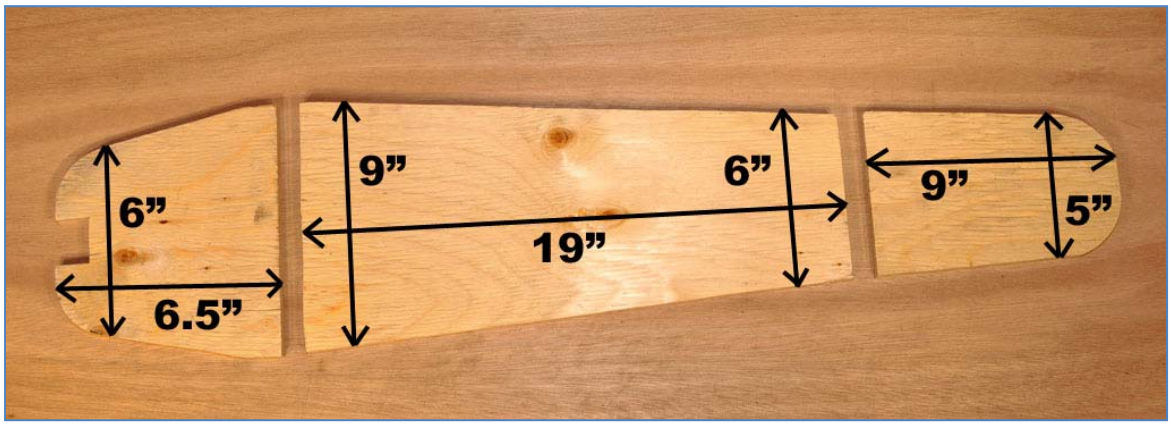

Figure 87 – Making a simple wood seat base

Seating, like handle bar position, is one of those things you might have to experiment with in order to get what you want. On a racing machine like the Tomahawk, the main goal is to keep the rider low and laid back, so padding will be minimal. The truth is a bare wood seat is will be so much better than any upright bicycle torture seat, so no matter what type of padding you choose it will be a welcomed break from the wedgie effect!

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The seat front, base, and back tubes determine the length of your seat, and the size of your butt will determine the width. The basic dimensions shown in Figure 87 are probably just fine for most people, but feel free to modify them in any way you like. I am using half inch plywood for my seat boards.

Figure 88 – Brackets to hold the seat boards

To fasten the seat base and back boards, a few shelf brackets can be bent to the necessary angles as shown in Figure 88. You could also use some 1/8 flat bar as well.

Figure 89 – Joining the seat boards

The brackets will join the seat base and seat back together as shown in Figure 89, making the final seat very solid. The metal brackets are easy to bend either way to fine tune the angle of the seat when fitting it into the frame.

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Figure 90 – Adding a back support

A back support is a necessity on such a laid back racing machine. You will need to experiment with the position and height that suits your body size. Do not be tempted to make a head rest unless the roads you plan to race along are as smooth as glass. Trust me - every single bump or crack in the road will rattle your teeth and also make it impossible to wear a helmet. A head rest does not work! The back rest should not be any higher than the base of your neck. A 1 inch tube (Figure 90) is good enough to support the back rest. Tack weld it at first and then adjust it when your seat is padded later.

Figure 91 – Test fitting the seat base

Figure 91 shows the seat base being tested on the frame. I carved my seat base so that it extends a bit past the front seat tube, but that is an optional step only done for looks.

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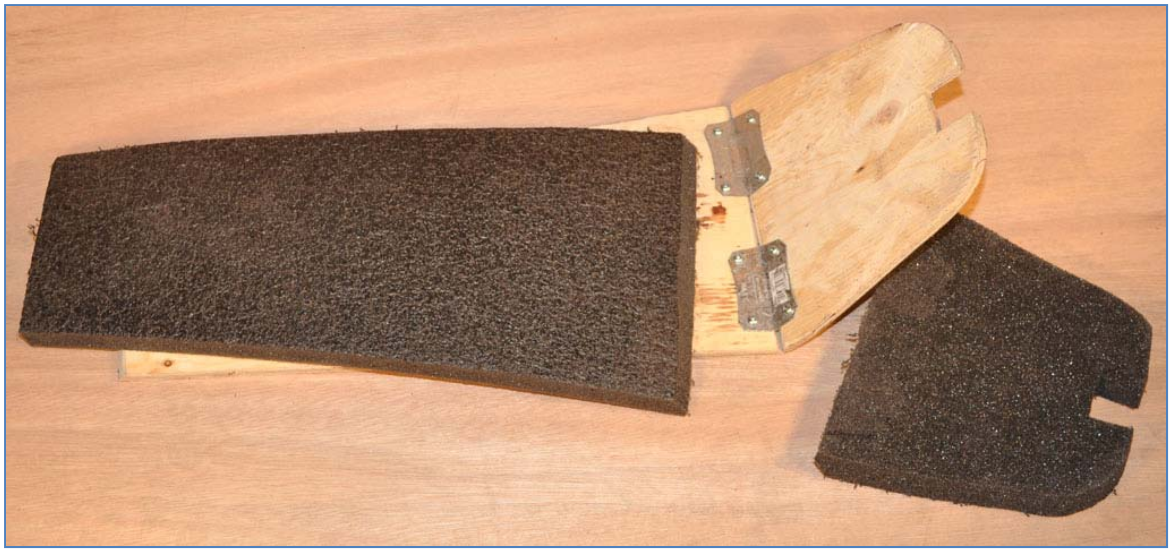

Figure 92 – Padding the seat boards

On my racing machines, I use very hard and thin black foam like the pieces shown in Figure 92. This type of foam is called “dense foam” and has almost no give to it at all, but this allows you to move around on the seat for optimal pedaling position. When sprinting, I lean way back and push hard into the cranks, but when hill climbing, I like to sit up a bit and spin like crazy, so the hard foam does not constrict my seating position.

Packing foam (hard white foam) is also a good choice, but do avoid the kind of foam you find in furniture as it is just way too soft. Also, be aware of the thickness of the foam if your frame measurements are very tight due to your inseam.

Figure 93 – Foam glued and trimmed

This simple foam and wood seat is so much lighter and easy to make than a mesh seat. A mesh seat is certainly more comfortable, but probably a bad choice for a lowracer. To make the foam look perfect as shown in Figure 93, I first rough cut it a bit larger than the seat bards, glue it down using spray adhesive, and then trim around the edge, using a flap disc as if it was a router. Although I now have to touch up the grey painted edge of the boards again, the foam does look perfect.

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Figure 94 – The completed foam board seat

The completed wood and foam seat is shown sitting on the frame in Figure 94. Sure, an expensive carbon fibre recumbent seat would look a bit nicer, but for $5 worth of material, I am not complaining! If you are really good with woodworking, you may even try a custom formed seat using several thin layers of plywood glued together to conform to your optimal seating position. Our builders gallery has many good examples of creative answers to recumbent seating, so have a look there for some ideas as well.

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ADJUSTABLE BOTTOM BRACKET

Figure 95 – Adjustable bottom bracket parts

It would be very difficult to guess the exact placement of the bottom bracket for your inseam (leg length) without making a small error. A fixed bottom bracket also means that you could never alter the seat, or adjust the Tomahawk for anyone except for yourself, so an adjustable bottom bracket is the only logical option.

If you cut the bottom bracket from an old bicycle frame, and leave a 12 inch or longer section of the seat tube connected (for the front derailleur), you can create a very functional adjustable bottom bracket with nothing more than a pair of steel plates. The bottom bracket and included seat tube will be mounted to the main boom with a clamp arrangement that allows the assembly to be placed practically anywhere on the boom to allow riders of varying heights to ride the bike. The two plates shown in Figure 95 along with the bottom bracket and seat tube stub will form the sides of the clamp that will hold the bottom bracket against the side walls of the main boom as they are forced together by two bolts.

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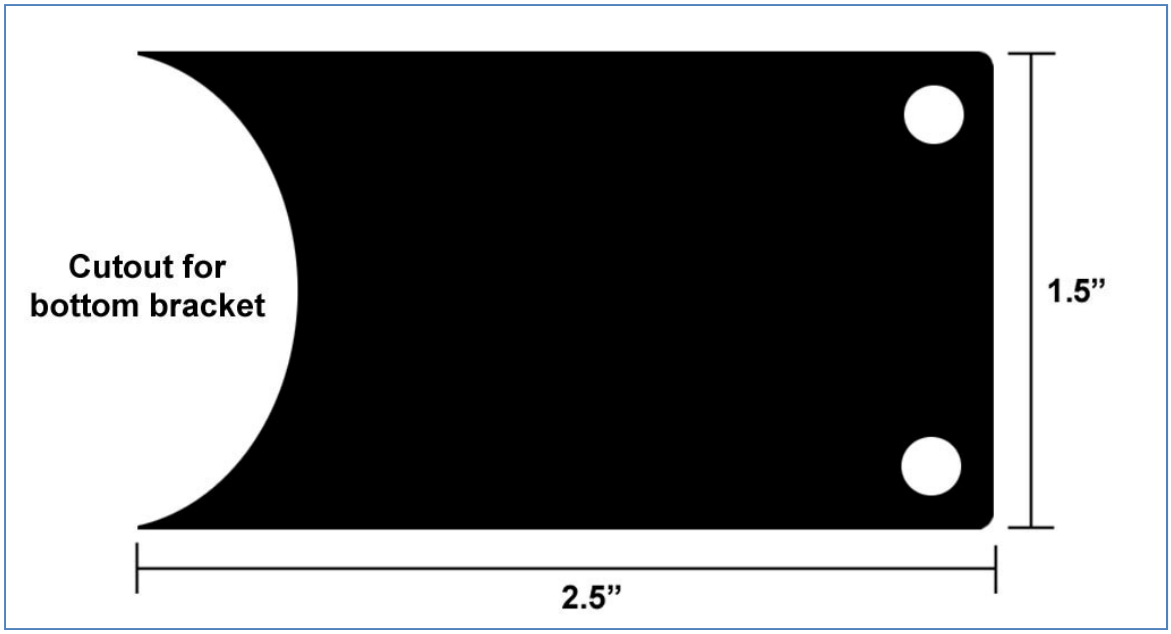

Diagram 5 – Adjustable bottom bracket clamp plates

The bottom bracket and front derailleur tube move together along the front boom, so you do not need to worry about the position of the derailleur over the chain ring. The chain is cut to the perfect length once the bottom bracket has been adjusted for the main rider, but will still allow a few inches of adjustment in either direction without a chain alteration due to the spring loaded rear derailleur. Of course, the difference between a 6 foot 5 inch versus a 4 foot tall person will likely require some chain adjustment, but this can be done in less than a minute with an inexpensive chain link tool.

Cut two 3/16 inch thick pieces of plate or sheet to make the shapes as shown in Diagram 5. The round area is cut to conform to whatever size bottom bracket you decided to go with, and the two bolt holes will be drilled for 3/8 inch bolts. The bolt holes are drilled at the edge of the plates so that there is 1/8 inch of material between the hole and edge of the plate. These two plates will form a "vice" that will clamp the bottom bracket to whatever position on the main boom you want.

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Figure 96 – The plates will conform to the bottom bracket

Trace around the bottom bracket shell to draw a line on the plates as shown earlier in Figure 95. The marker line should meet the corners of the plate to ensure that you don't cut out too much off of the plate when grinding out the rounded area. If you take too much metal away from the plate, there will not be enough room between the bottom bracket and the clamping bolts for the main boom.

When grinding out the traced circular area for the bottom bracket as shown in Figure 96, place both plates in the vice so they can be done at the same time; this will ensure that both plates are exactly the same size. Try to make the gap as small as possible around the bottom bracket shell so that there is less distortion as the plates are welded. If the bottom bracket becomes overly distorted, it will be a serious challenge trying to screw the hardware back into the bottom brackets without stripping the threads.

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Figure 97 – Clamping the plates for welding

To get the two plates aligned with each other and at the correct spacing, a bit of frame tubing can be clamped between the two plates as shown in Figure 97. This will allow you to set the bottom bracket into the correct position for tack welding and ensure that both plates are aligned with each other so the bolt passes easily through both holes.

I also placed a sheet of paper between each plate and the side wall of the tubing to allow for a little clearance between the clamp plates so that the unit is not so difficult to slide when making adjustments. Without the small gap, it is easy to scratch the paint if you plan to move the bottom bracket around a lot.

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Figure 98 – Proper front derailleur tube angle

As shown in Figure 98, you can use an adjustable square set to the required 56 degrees to set up the bottom bracket and derailleur tube to place two small tack welds at the top of the joint. It may be a bit tricky to get the first tack weld in place while holding the bottom bracket in position, but once this is done, the rest is easy.

With the piece of frame tubing as a guide, you will automatically have the correct distance between the plates. Now, you will need to ensure that there is approximately equal distance between each plate and the edges of the bottom bracket. In other words, the bottom bracket will be in the center of the main boom as viewed from above.

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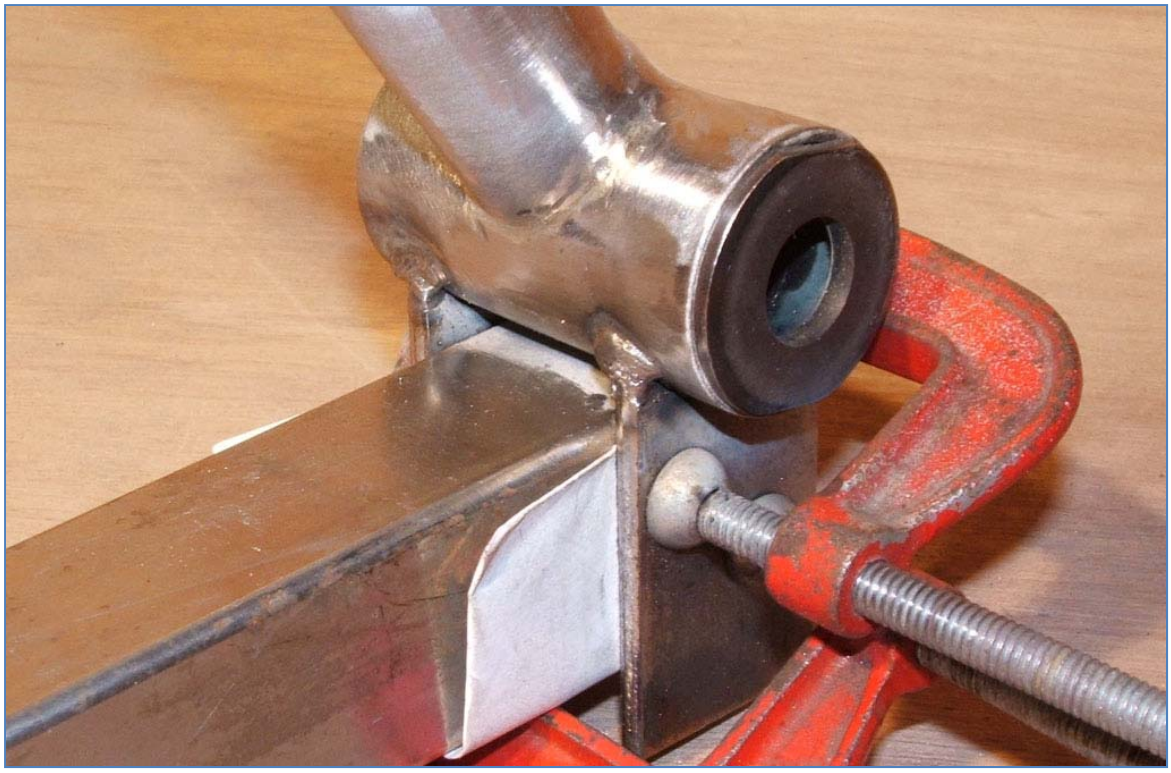

Figure 99 – Clamp plates tack welded to the bottom bracket

Figure 99 shows the first tack welds done at the top edge of the plates in order to secure the parts together. Ensure that the derailleur tube angle is close to 56 degrees and that the bottom bracket is at 90 degrees to the square tubing. You can also move the clamps to hold the plates in a position that will allow you to weld around the entire joint.

Also, welding is only done on the outside of the joint, not between the plates. If the inside of the joint is welded, the weld bead will not allow the bottom bracket to sit directly on the frame tubing and could cause alignment problems. Because of the way the clamp system works, there would be no added benefit from welding the inside of the joint anyway.

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Figure 100 – Marking a line for bolt hole drilling

The two plates will form a vice-like grip on the frame tubing when the 3/8 inch bolts are tightened. To drill the holes into the plate, draw a line that represents the bottom corner of the frame tubing as shown in Figure 100. Now, you can punch and drill the holes using the lines as a guide that will allow you to ensure that the holes stay below the line. If the holes are not below the line, you will not be able to pass the bolt through both plates because it will hit the frame tubing instead.

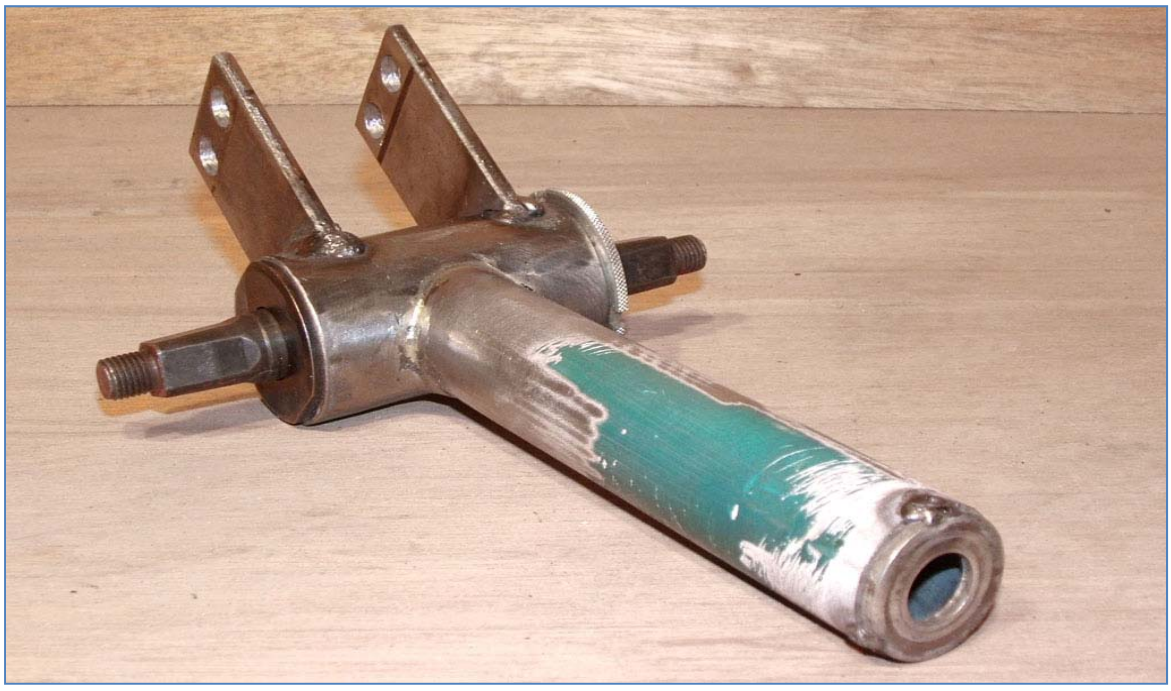

Figure 101 – Capping the end of the derailleur tube

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With the derailleur tubing cut to length, it is a good idea to cap off the open end of the tubing so that it looks better and keeps any moisture out. As shown in Figure 101, a washer is welded over the end of the tube and then completely filled in around the joint and the hole. To fill in the washer hole, several passes are made around the edge until completely covered in weld metal.

Figure 102 – Completed adjustable bottom bracket

After welding the washer in place and grinding the area clean, you can't even tell that the tube shown in Figure 102 once had an open end. Going the extra mile can make your final product look very professional, possibly even better than some mass produced machines, since they might have simply capped the hole with a plastic plug to save time and costs.

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THE FRONT BOOM

Figure 103 – Measuring for the front boom angle

There is only one last part of the frame that needs to be built, and that is the front boom, which will hold the bottom bracket to the head tube and allow for slight adjustments to be made for leg length. The main geometry goals remain the same as what was shown earlier in Diagram 4 and Figure 66 as well as Figure 104, which is to set the lowest pedal stroke at approximately the same height as the seat base corner (if you can). I say "if you can" because shorter riders may need to raise the cranks up to clear the front wheel, but you would already know this from earlier testing.

Place your seat on the frame and sit as far back as you can, pushing your leg out parallel to the ground as shown in Figure 103. Have a helper tell you the measurement to the underside of your shoe as you hold the start of the tape on the front edge of the head tube. This length will be the length you initially cut the tubing for the front boom. My front boom needed to be 24 inches.

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Figure 104 – Measuring for the front boom angle

This is what you want, if your leg length allows. Figure 104 shows the pedal strike zone (red) away from the front wheel, as well as the optimal height of the lowest pedal position (blue line), which is about the same height as the corner of your seat. Riders with long legs may choose to run the bottom bracket even lower, but if you go too low, the top front of the seat may dig into your legs. On the other hand, if you run the bottom bracket too high, you will be seeing a lot of your own feet while you ride.

Try to get the new front boom tube clamped into position as shown in Figure 104, using a clamp on the head tube and some object to hold it up to the optimal height.

Figure 105 – Mark the front boom for cutting

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Once you have the front boom set up at the angle that works best for you, draw a line at the end that matches the angle of the head tube as shown in Figure 105. All that is left to do is fishmouth the end of the tube and weld it to the head tube in order to complete your Tomahawk frame.

Figure 106 – Drawing the fishmouth cuts on the boom

The process for making the fishmouth cuts on the front boom is the same as it was for the front seat tube. As shown in Figure 106, a piece of tubing or head tube section is used to trace the round pattern at the corners of the cuts that will be made.

Figure 107 – Fishmouth cuts made on the front boom

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Once the fishmouth cuts are made using a grinder disc to rough cut them, clean them with a round file so they form a good joint for welding. Figure 107 shows the two completed fishmouth cuts at one end of the new front boom tube.

Figure 108 – Tack weld the top of the front boom

Install the front boom in the center of the head tube and place a tack weld on the top as shown in Figure 108. Try to get the boom in line with the other frame tubing by viewing it from both ends while on your workbench. Some adjustment will be easy to make later, but the closer the better for now.

Figure 109 – Checking the strike zone

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It is important to check your crank to wheel strike zone area once more since an unequal fishmouth on one end of the boom may change the desired angle of the front boom. Figure 109 shows the half inch clearance between my front wheel and pedal as the bottom bracket is set into the exact position for my inseam. Close, but safe!

Figure 110 – Welding the front boom tube

Once again, the welding is done in the require order of top, bottom, and then sides as you join the front boom tube to the head tube as shown in Figure 110. Leave a pair of head tube cups installed to help minimize distortion due to heat.

CHAIN TRANSMISSION

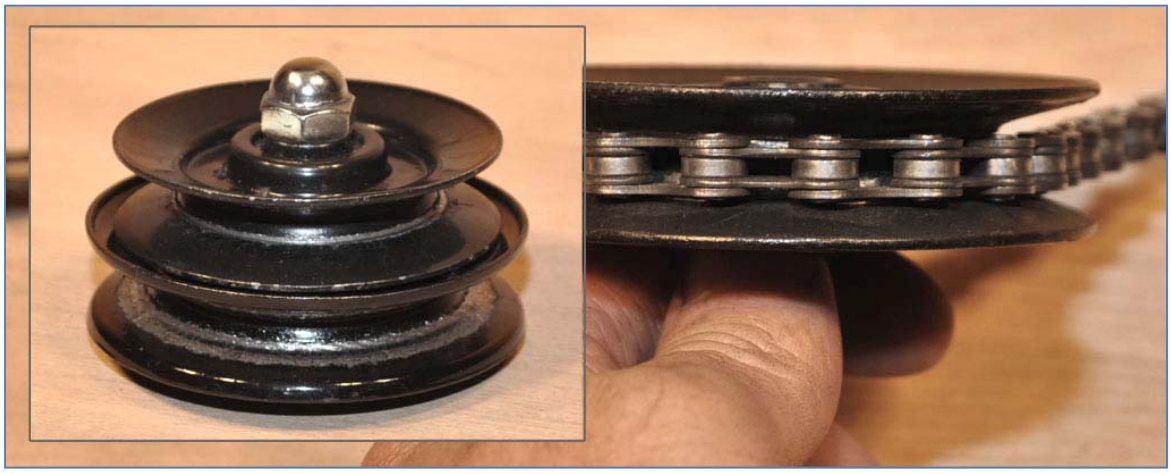

Figure 111 – Pulleys will be used to guide the chain

The chain must sneak over the front wheel and then head under the seat before it reaches the rear drive wheel, so you will need a few guide pulleys in order to make this happen. The chain that enters the top of the front crank ring is called the drive chain as it does all of the work. The other side of the chain is

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called the “return chain” and it is never under any tension at all. For this reason, a smaller pulley or even a grooved out skate blade wheel is fine, but the drive chain requires the proper idler pulley.

The best option for the drive side pulleys is a 2.75” to 3.5” diameter belt pulley made for a ½ inch v-belt with a bearing hole of half an inch or 3/8 inch. This pulley will come with a decent bearing in the center and will allow the chain to sit nicely in the groove, making no sound whatsoever as you pedal. Figure 111 shows how the v-belt pulley holds the bicycle chain perfectly.

As you have probably seen be reading ahead, there are four guide pulleys, which are set up as pairs of two. I found that a slightly smaller v-belt idler pulley was able to rest just inside the flange of the larger 3 inch pulley as shown in Figure 111, so this worked out nicely. The more the pulleys stick out from your frame, the more you will notice them along your leg, so try to keep them as thin as possible.

Figure 112 – Routing the drive chain

Start by clamping the larger pulleys (drive chain pulleys) to the frame as shown in Figure 112 so that the chain slips under the seat without hitting either the front tire of seat boards. The larger drive chain pulleys are close to the frame and the return chain pulleys (smaller pulleys) will be on the bolt on the other side of the drive pulleys. When you have the chain pulled tight and routed properly, mark the point on the frame through the bearing hole where the bolt will need to be installed.

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Figure 113 – Routing the drive chain

Once you have the positions of the idler pulleys marked, weld the appropriate diameter and length bolts to the frame as shown in Figure 113. Remember that two pulleys need to share each bolt, so make them long enough and cut them down later.

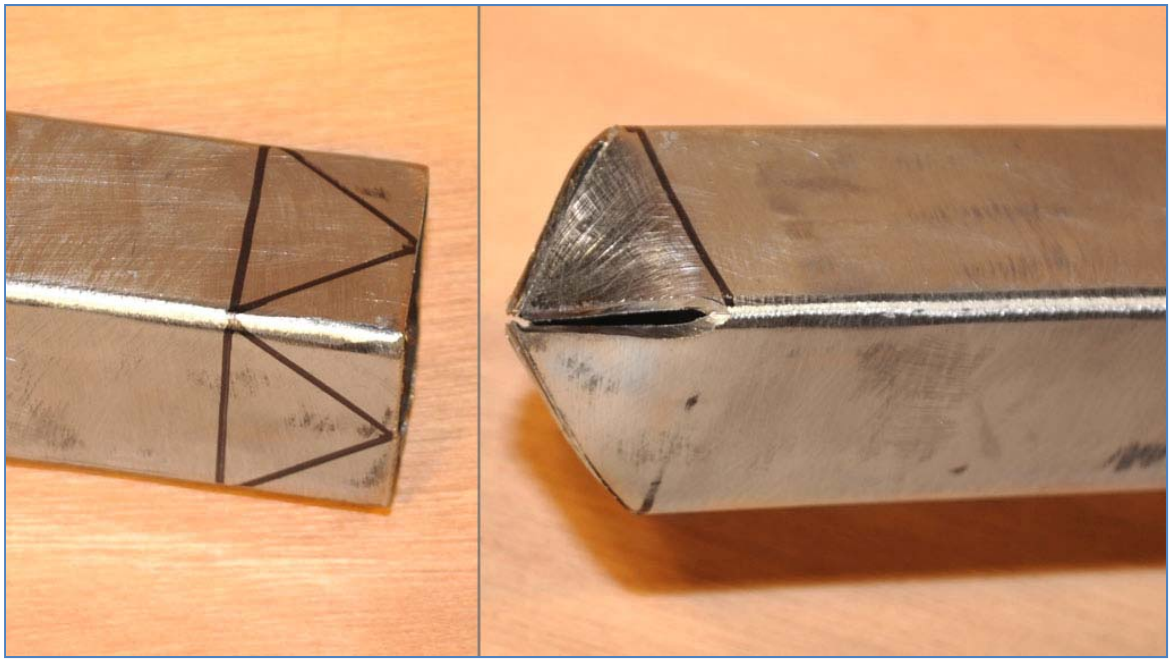

Figure 114 – Capping off the boom tube

With your seat installed, chain routed, and bottom bracket set to your optimal position, you can safely trim the extra boom length that extends more than 1 inch past the location of the bottom bracket. If you intend to allow taller riders to share your bike then keep the length, but if not it is only a waste of tubing. A fancy way to cap the open end is shown in Figure 114 and 115, cutting triangular sections from the end and then folding them over to create a diamond head.

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Figure 115 – Finishing the boom tube cap

After a little welding and grinding using the flap disc, the diamond shaped end cap takes form as shown in Figure 115, giving the end of the boom a cool finished look.

Figure 116 – Adding the seat tabs

To securely fasten the seat to the frame, a set of seat tabs cut from some 2 inch long pieces of 1 inch thick flatbar are used as shown in Figure 116. You will need one pair for the seat base, two pairs for the seat back, and a pair for the back rest.

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Figure 117 – Installing the seat

Eight seat tabs fasten the seat to the frame as shown in Figure 117. When you are installing the tabs, place a tube across the top of the frame to help align them for welding.

Figure 118 – Setting the proper chain length

Although you may have to experiment with the chain length to get it perfect, a good start is shown in Figure 118. Place the chain on the largest front ring, the middle rear ring, and when the rear derailleur wheels are vertical; this seems to be a good length. For more on chains, see the main page of our website.

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INSTALL HANDLEBARS

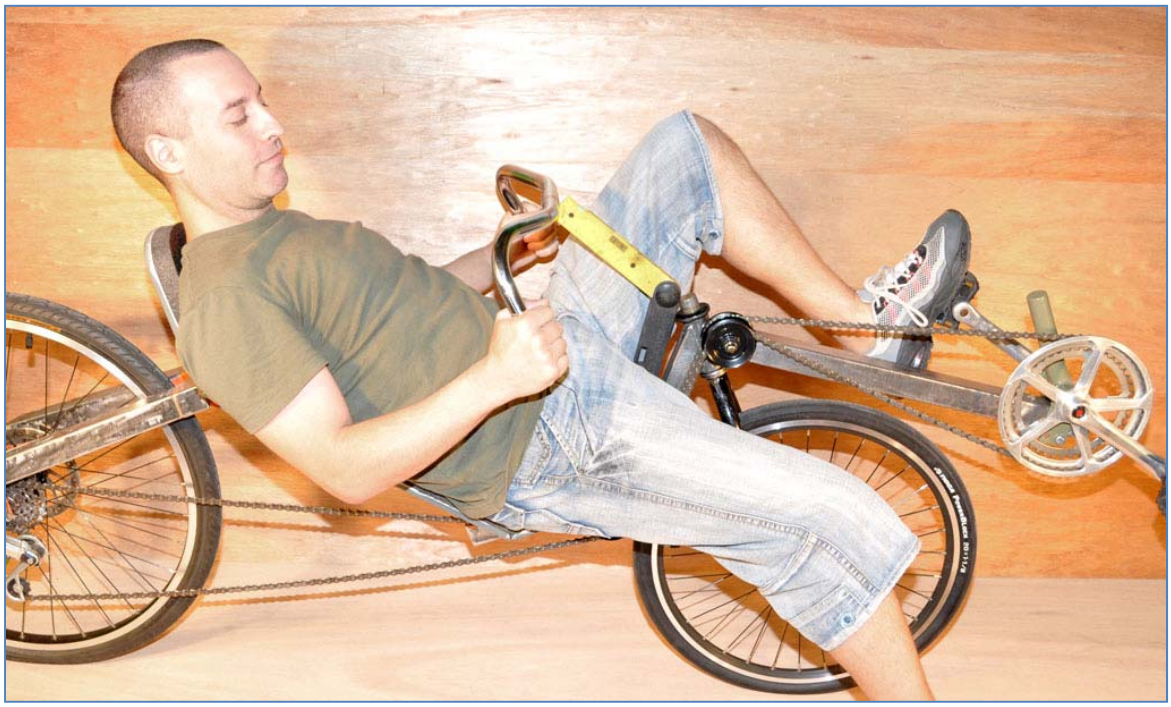

Figure 119 – Testing some handlebars

There are so many options and possibilities when it comes to handlebars, but on a lowracer, the best performance will come from keeping your arms close to your body to reduce wind resistance. For the extreme speed demon, a minimal 8 inch straight bar might give the optimal slipstream, but this will make the lowracer a bit more challenging to ride in city traffic. A good compromise is a pair of “granny bars” like the ones I am holding in Figure 119, as they wrap around your body, keep your arms fairly close, but allow very stable control. Where you want to have your bars is totally up to you, and you will need to sit on the seat and find your comfort zone. I used an adjustable square to memorize my optimal angel and position as I held the handlebars in place.

Figure 120 – Making an extended gooseneck

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Once you have found your optimal handlebar style and position, you will likely be in need of a very long gooseneck. Since most standard bicycle goosenecks are only a few inches in length, you will have to make your own, but this is an easy procedure. Using the standard steel gooseneck shown in Figure 120 along with a bit of handlebar tubing, you can easily cut and relocate the handlebar mounting clamp where you need it.

Figure 121– Extending the gooseneck

Cut the clamp and the stem from the gooseneck as shown in Figure 121, making up the required distance with some handlebar tubing or similar size bicycle tubing. A steel seat post or even 1 inch square tubing can be used for this job.

Figure 122 – Welding the gooseneck extension

Start your gooseneck welding at the stem as shown in Figure 122. Initially, tack weld and test the assembly to ensure it is the length and angle you wanted before completing any of the welds. All gooseneck welds need to be done properly and around the entire joint.

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Figure 123 – Welding the gooseneck clamp

The clamp will need to be aligned properly to the stem, or your handlebars will be tilting to one side. As shown in Figure 123, a good tack weld at the clamp is first made so you can insert the handle bars for an alignment check while installed on the fork stem.

Figure 124 – Checking the handlebar alignment

With the clamp tack welded to the gooseneck stem, install your handlebars and then place the assembly into the fork stem as shown in Figure 124. The handlebars should look level when viewed from the front of the bike, but it will be easy to force the clamp into the perfect alignment now.

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Figure 125 – Completing the gooseneck extension

Once alignment has been tested using the handlebars, complete the gooseneck clamp welding as shown in Figure 125, ensuring a good strong weld around the entire joint.

Figure 126 – Are you ready for a test run?

Besides the fact that you cannot stop, it would be possible to find a quiet parking lot and have a short test run just to ensure that you like your new handlebars. You can adjust the front and rear derailleur limit screws to place the chain on the middle gears and get a feel for how the lowracer will feel. Don't worry about the wobbles just yet because you will have those for a few hours before hitting the streets with proper brakes.

Also, take note of your optimal bottom bracket position now and mark this down so that when you install it back on the painted frame, you won't have to mess around and scratch your paint!

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BRAKES

Figure 127 – Aligning a disc brake

The Tomahawk can use any combination of pad or disc brake on either wheel, and I have chosen a rear disc and front pad brake so I can demonstrate them both in the plan. A rear disc brake is fairly easy to install even though the tolerances need to be very close in order to avoid rubbing or ringing. If you look carefully at the caliper hardware, you will see that there is a pad area for the disc and then a small gap for clearance inside the slot. The goal is to have the pads hitting directly on the rotor area without the edge of the rotor rubbing on the caliper body.

Most disc calipers allow you to adjust the pad tension so you can lock the brake right to the rotor as shown in Figure 127 by simply cranking the tension all the way up while the pads are in the exact place you want them. If your brake hardware cannot lock, use a zip tie or small clamp to hold the arm in the engaged position to do the same thing.

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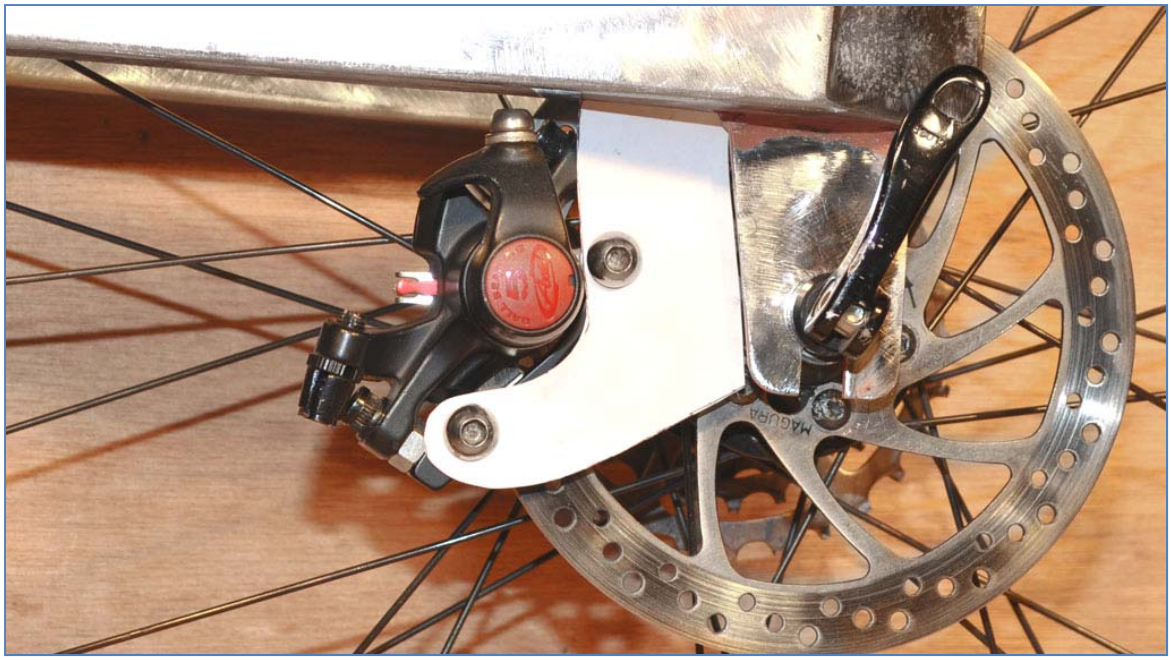

Figure 128 – Completing the gooseneck extension

Once the caliper is locked to the rotor for optimal pad contact, carefully install the rear wheel and get the caliper hardware sitting near the underside of the left fork leg as shown in Figure 128. If it looks as though your cables will fit properly without hitting the frame tubing, hack away on a paper template until you have something that looks similar to what is shown in Figure 128. All brakes are slightly different, so you will need to do this by trial and error using your own brake hardware.

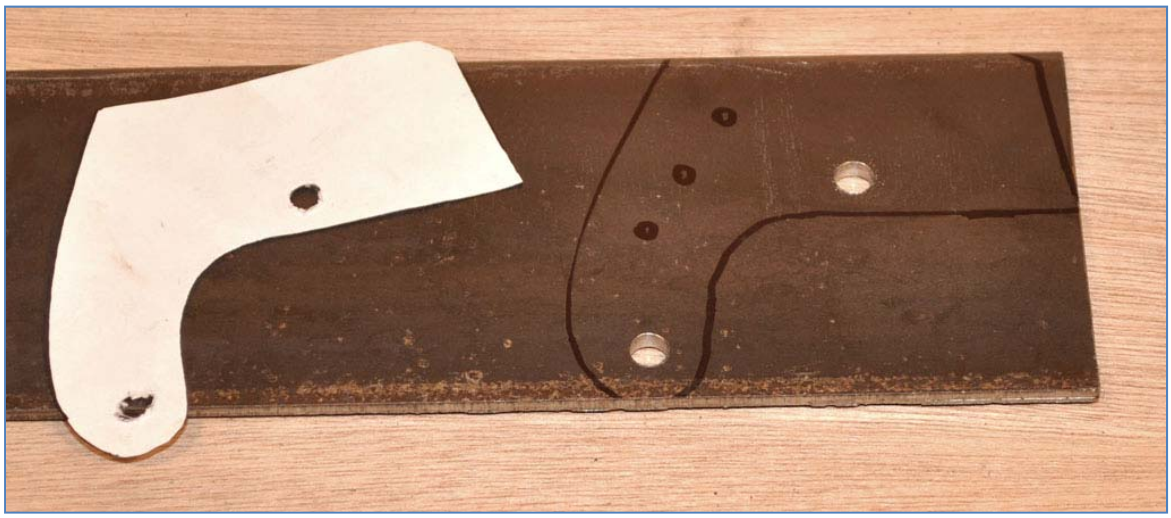

Figure 129 – Cutting the brake arm from the template

The brake mounting arm is cut from any piece of 1/8 inch thick flatbar or scrap plate using the paper template made in the last step. Figure 129 shows my arm ready for cutting after tracing the template to the flatbar.

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Figure 130 – The completed disc brake mounting arm

The disc brake mounting arm is cut and ground smooth using the flap disc to produce the part shown in Figure 130.

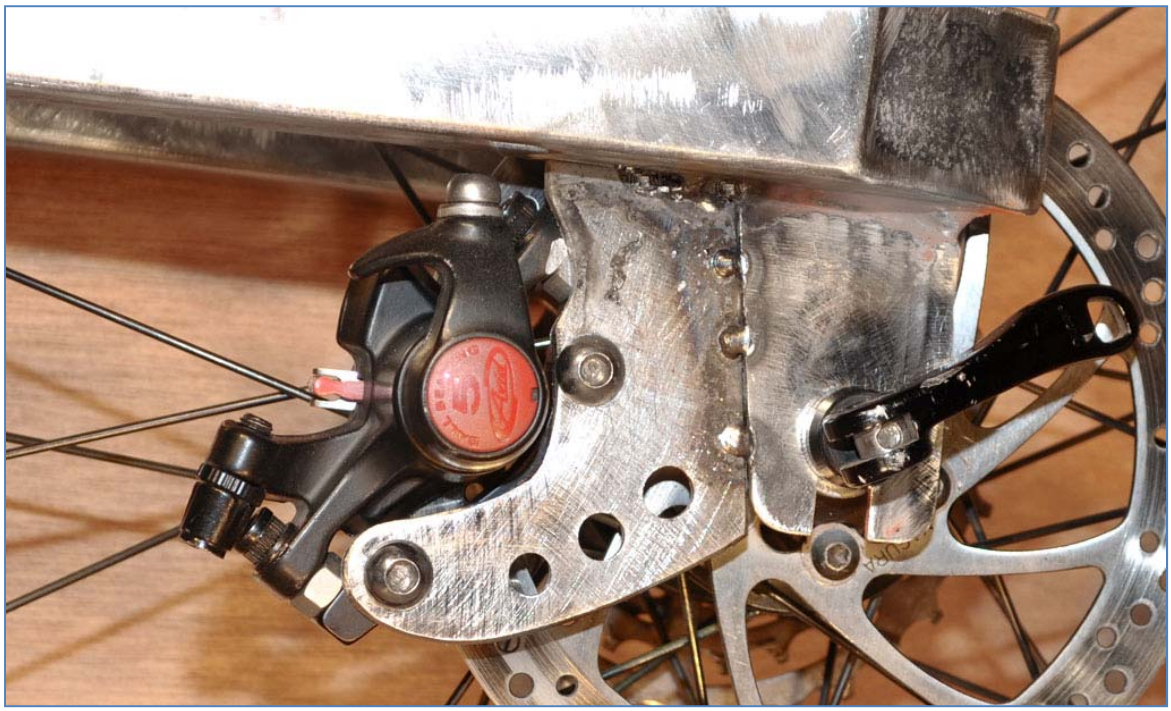

Figure 131 – Installing the brake hardware

The best way I have found to painlessly install the brake hardware is by locking it to the actual disc and making a few tack welds while the hardware is in place. You have to tape up your brake hardware, rotor, and place a rag around your rim to avoid damage from welding spatter, but this method almost

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always produces a perfect alignment in the first attempt. Figure 131 shows the disc brake mounting arm tack welded to the frame and dropout after removing my protective tape from the rotor and caliper. Don't weld the entire joint this way though, or the radiating heat will melt your caliper hardware!

Figure 132 – The brake mounting arm fully welded

Once you have the brake mounting arm tack welded, release the caliper tension and give the wheel a spin. A new brake will have some slight rubbing as the self centering mechanism is working, but there should not be enough friction to stop the wheel from spinning around freely. If there is excessive friction, look into the slot to see which way your mounting arm needs to be "tweaked" with a few hammer taps. Once you are satisfied with alignment, weld the entire mounting arm to the frame and dropouts as shown in Figure 132.

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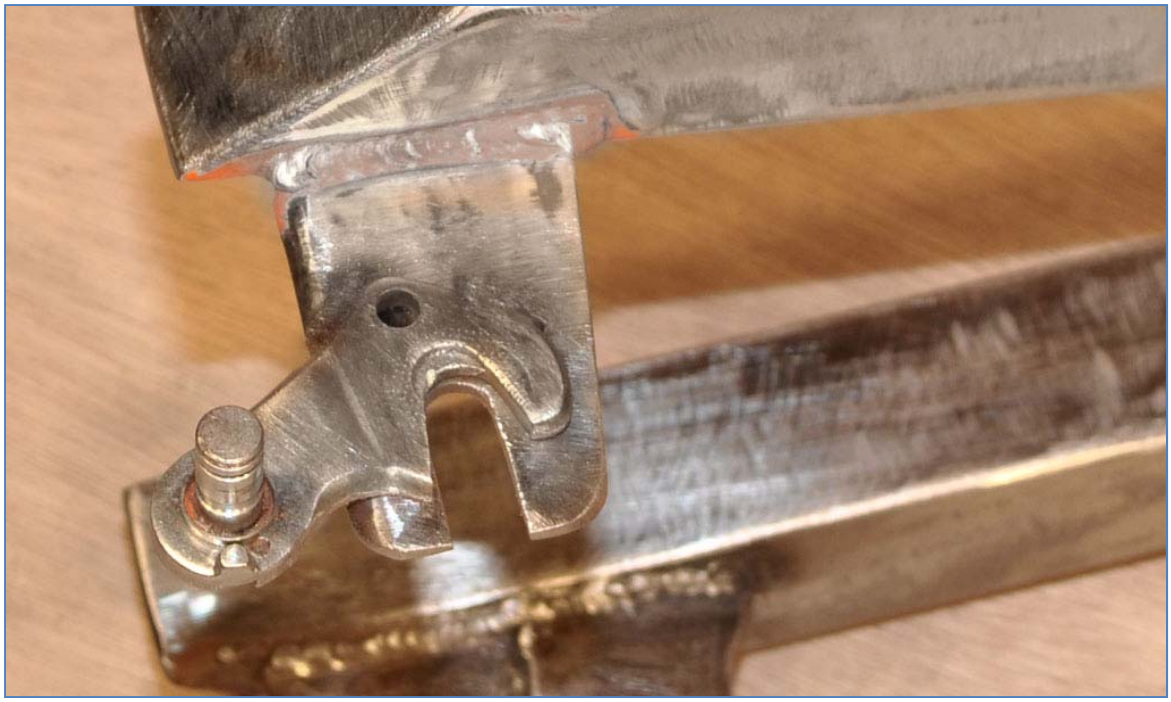

Figure 133 – Adding a rear derailleur tab

There are two main types of rear derailleur mounting systems, the friction fit dropout type and the tab mounted type. On the dropout style, the rear wheel nut hold the mounting plate to the rear dropout by friction and a small guide bolt keeps it at the correct angle. Because the rear of the Tomahawk is not the same as a standard cycle, you will likely have to slice a small bit away from the slot of the friction fit derailleur plate and weld it to your dropout as shown in Figure 133. If you look at the way a standard derailleur sits on a bicycle in relation to the chain, then you can see why this may be necessary.

A tab mounted derailleur does not include this flat slotted plate, but will still require you to weld the tab and pin to the correct place, just as it was on the frame you took it from. A complete working upright cycle is a great reference, and there are some more derailleur and shifter basics available on the home page of our website.

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PRIME AND PAINT

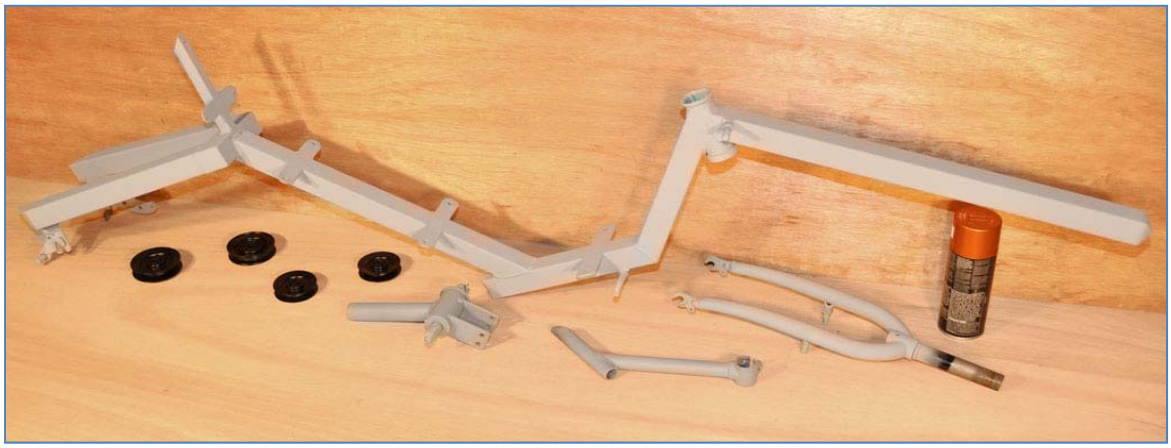

Figure 134 – Priming and painting the frame

So now you are ready to paint your new lowracer! I only use department store spray cans, but usually end up with a paint job that looks as good as factory. Of course, spray painted frames will scratch easier than a professional powder coat, but unless you plan on going into battle with your bike, this is not a worry. To get the frame nicely primed as shown in Figure 134, start by lightly sanding the tubing with some fine grit emery cloth just to get rid of any burs or weld spatter. Tape up any bearing surfaces and then follow the typical directions on the can, which will tell you to make short strokes with the nozzle held about 12 inches away from the frame. Keep moving around the frame until it goes from a light dusting to a full coat, never spraying the same place with too much paint or primer.

Figure 135 – painted and curing for a few days

After the primed frame has left to “cure” for a day or two, follow the same slow and easy painting process using the spray paint, never trying to cover up the area in one quick blast. The incredible color shown in Figure 135 is actually high heat engine paint called “burnt copper”, but I liked the color and it was just fine used as regular paint. Again, wait for at least a day before assembling the bike as fresh paint only becomes “hard” after many days. In a week, it will be as tough as it will ever get.

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FINAL ASSEMBLY

Figure 136 – Fresh grease for all bearings

When it comes time to assemble your bike, clean and re-grease all bearings with some kind of axle grease. Figure 136 shows the head tube bearings after being cleaned and greased.

Figure 137 – The assembly process part 1

The easiest way to begin assembling your bike is to start by installing both wheels. If you can find some way to wedge the rear wheel between two solid objects, this will lessen the risk of having the bike fall over and scratch your new paint job. Since I am unable to wait more than a day due to low patience, I have to be careful with my fresh paint!

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Figure 138 – The assembly process part 2

Cranks chain, and idler pulleys are the next part of the Tomahawk to become assembled. After testing the transmission, I then added the handlebars so the bike was easy to move around the garage. Since you made note of your bottom bracket position way back in the test ride stage, you won't have to scratch your paint trying to set it up – just park the install point and then drop the plates straight down into position. The scratches will be under the plates this way.

Figure 139 – The assembly process part 3

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When bolting down the idler pulleys, rounded cap nuts are best, especially on the top bolt that may come into contact with your leg. Figure 129 shows the complete transmission installed, along with the front derailleur which is being tested for proper movement.

Figure 140 – The assembly process part 4

Your last puzzle before leaving your cycling buddies in the dust will be to get your levers and shifters in a place that allow for easy accessibility without being in your way. Smaller handlebars can be a real challenge, but the curved bars I shown in Figure 140 have plenty of room for both shifters and brake levers. I am a fanatic for those old school road bike lever type shifters, so I have a set installed on the extended gooseneck to keep cables out of my face as much as possible.

Figure 141 – The assembly process part 5

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When adding your cables, never use worn or rusted cables and avoid and sharp bends. When you need to make a tight circle in a cable, use those little metal elbows called “cable noodles” like the ones shown in Figure 141 on both my shifters as well as the front brake. Your local bike shop should have them in stock. I salvage most of my parts from old bikes, but usually purchase new cables just to be safe.

Figure 142 – The assembly process part 6

Sometimes you can sneak a cable behind a tube out of view, or even drill into the frame to hide them. I usually run them all at first and then add zip ties to get them out of view as much as possible. Figure 142 shows the rear of the assembled Tomahawk after adjusting the disc brake tension for optimal braking.

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READY TO RIDE

Figure 143 – Ready to race!

After a few hours of careful assembly and cable routing, the completed Tomahawk rolled out of my garage for its inaugural test run. Figure 143 shows the final result – a sleek, professional looking lowracer that just screams out SPEED! Before you set off into the sunset, your brakes and derailleurs will need fine tuning, unless you managed to really get lucky during the assembly process.

Figure 144 – The completed Tomahawk Lowracer

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Try your full range of gears and test your brakes on a nice quiet street before scaring those upright riders on the cycle trail! The derailleur adjusting screws usually need another fine tuning after adding cables, but that won't take long.

Figure 145 – Your first recumbent experience

If this is your first riding attempt on a load back lowracer then get prepared for an exhilarating experience! You might want to find a nice open parking lot to work out your initial jitters as you begin to become one with your racing machine. Starting off is much the same as any bike – set your gears to a lower speed, place one foot on the top crank as shown in Figure 145 and then push to launch. Your first few hours may seem "twitchy" as you get used to the steering, but before long you will be able to ride steady at any speed, even with one hand off the handlebars.

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Figure 146– Getting familiar with the steering

The steering characteristics are certainly going to feel different than your upright bicycle, specifically into fast corners. Once you begin to really 'feel" your lowracer, you will enjoy putting it hard into corners, leaning over while you are still able to pedal and keep your speed high. Your only limitations on cornering speed will be road conditions. Dirty roads, small rocks, and wet surfaces are hazards for high speed cornering, but other than that you have very few limitations beyond your own leg pushing abilities. Your upright cycle riding buddies will be hard pressed to keep up to you on the straight stretches, corners, and especially on a windy day. Having such a small frontal area to break the wind will give you a large advantage over those on upright cycles.

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Figure 147 – The lowracer experience!

Try a few fast zig zags, small circles, and stops as you get used to the feeling of your lowracer. It won't take long before you and your racing machine become one! The experience of being in such a low and laid back position is best described as being the pilot of a jetfighter!

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Figure 148 – Leave them in the dust!

The only unfortunate thing about owning such an efficient racing bike is that the other cyclists will only get to see the back of your head most of the time! It is so much fun to sneak up on a pack of cyclists on a long stretch and just slip right on past as they fight the wind with all of their energy going to waste!

We hope you enjoyed building this project. The feeling of accomplishment defies words when you first hit the road, and the look on people's faces when you tell them you made your ride is priceless. Thanks for your support, and we hope your build progresses smoothly. With a little patience, a pile of scrap bicycle parts, and some trial and error, you can create just about any human powered vehicle imaginable.

There is plenty of room for modification on this project, so please send us your completed photos for the Builder's Gallery so that others can see what you have done. If you need any assistance or want advice about an idea, stop by our Support Forum and introduce yourself to our many creative fellow garage hackers. Good luck on all of your projects. Have fun and ride safely. Brad and Kathy McGowan, Atomic Zombie™ Extreme Machines

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